Electronic Services - Los Angeles
M12473X

Instruction Manual

GENERAL ELECTRIC CO.
Instrumentation & Control
228 W. Florence Ave.
Inglewood, Calif. 90301

Inglewood, Calif. 90301

MODEL 823A/AG

AC/DC

DIFFERENTIAL VOLTMETER

FLUKE®

JOHN FLUKE mfg. co., inc.
SEATTLE, WASHINGTON

JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

November 1, 1963

GENERAL ELECTRIC CO.
Instrumentation & Control
228 W. Florence Ave.
Inglewood, Calif. 90301

MODEL 823A/AG

AC/DC

DIFFERENTIAL VOLTMETER

823A serial no. _____ and above.

823AR serial no. _____ and above.

823A/AG serial no. _____ and above.

823AR/AG serial no. _____ and above.

warranty

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forewarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to: JOHN FLUKE MFG. CO., INC., P.O. BOX 7428, SEATTLE, WASHINGTON 98133.

© COPYRIGHT, JOHN FLUKE MFG. CO., INC. 1971

CERTIFICATE of CALIBRATION

The John Fluke Mfg. Co., Inc. does hereby certify that this instrument meets or exceeds all published specifications and has been calibrated using standards whose accuracies are traceable to the National Bureau of Standards within the limitations of the Bureau's calibration services, or have been derived from accepted values of natural physical constants, or have been derived by the ratio type of self-calibration techniques.

SEAL OF CERTIFIED CALIBRATION

Applicable NBS Test Reports:
DC Voltage – 207627
AC Voltage – 807675
Resistance – 207693

Wilbur W. Fetrow
STANDARDS ENGINEER

Thomas B. Smith
MANAGER QUALITY ASSURANCE

COMPLETE AND RETURN THIS CARD TO ASSURE YOUR WARRANTY

Postage Will Be Paid By Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY MAIL
FIRST CLASS PERMIT No. 72 - MOUNTLAKE TERRACE, WASHINGTON

JOHN FLUKE MFG. CO., INC.

P. O. BOX 43210

MOUNTLAKE TERRACE. WASHINGTON 98043

Attn: Customer Service Dept.

FLUKE WARRANTY VALIDATION FORM

To assure validation of your warranty, please complete this form and return to John Fluke Mfg. Co., Inc.

MODEL _____ SERIAL NUMBER _____ PURCHASE DATE _____

What influenced you to buy this Fluke product? ☐ Advertising ☐ Contact by local salesman ☐ Other (specify) _____

Have you had previous experience with Fluke instruments? ☐ Yes ☐ No

Did you buy this Fluke product to: ☐ Replace existing equipment ☐ Expand your instrumentation capability

Other (specify) _____

Did you examine comparable products manufactured by other companies before deciding on Fluke? ☐ Yes ☐ No

When you received your instrument, was it in good physical condition? ☐ Yes ☐ No

Did it perform properly on initial operation? ☐ Yes ☐ No If no, what symptoms were present? _____

Have you owned or used Fluke products prior to this purchase? ☐ Yes ☐ No If yes, how do you rate Fluke products?

	Poor	Adequate	Superior		Poor	Adequate	Superior
Performance	☐	☐	☐	Useability	☐	☐	☐
Reliability	☐	☐	☐	Serviceability	☐	☐	☐

NAME _____ COMPANY _____

YOUR COMPANY'S PRODUCT OR SERVICE _____

STREET _____ CITY _____ STATE _____ ZIP _____ COUNTRY _____ (if outside US)

FORM NO. A773 - Rev. 2 - 2/75

TABLE OF CONTENTS

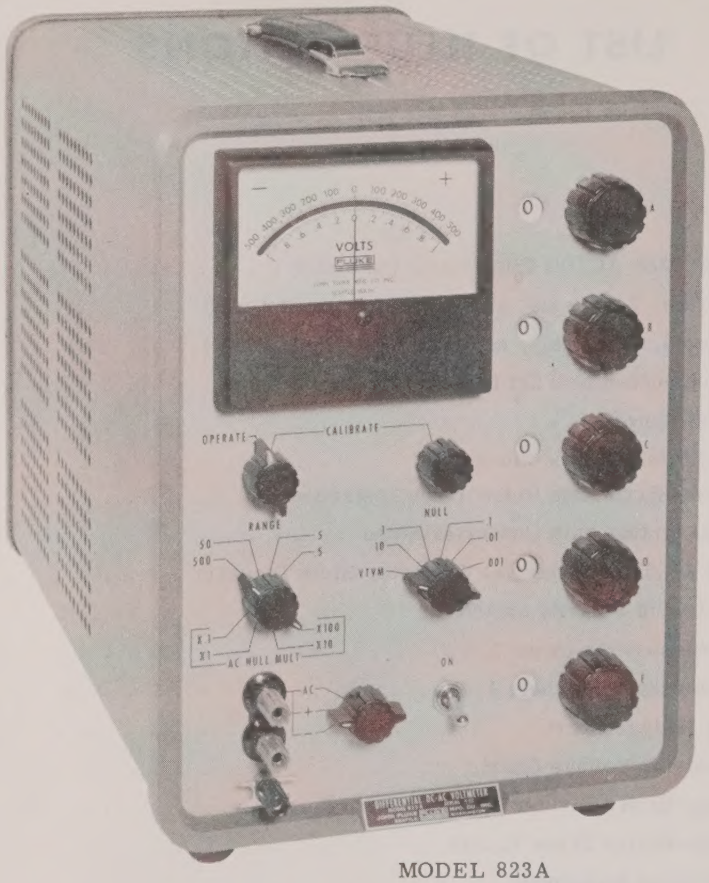
Section	Title	Page
I	INTRODUCTION AND SPECIFICATIONS	1-1
	1-1. Introduction	1-1
	1-2. Damage in Shipment	
	1-3. Specifications	1-1
II	OPERATING INSTRUCTIONS	2-1
	2-1. Controls, Terminals, and Indicators	2-1
	2-2. Zeroing Instructions	2-3
	2-3. Preliminary Operation	2-3
	2-4. Operation as a DC Differential Voltmeter	2-3
	2-5. Operation as an AC Differential Voltmeter	2-3
	2-6. Operation as a Conventional VTVM	2-4
	2-7. Measurement of Voltage Excursions About a Nominal Value	2-4
	2-8. Use of 823A with a Recorder	2-5
	2-9. Measurement of High Resistances	2-6
	2-10. Notes on Measuring AC or DC Voltages	2-6
	2-11. Notes on Measuring DC Voltages	2-7
	2-12. Notes on Measuring AC Voltages	2-7
III	THEORY OF OPERATION	3-1
	3-1. General	3-1
	3-2. DC Vacuum Tube Voltmeter	3-1
	3-3. 0 to 500 Volt Reference Supply	3-3
	3-4. AC to DC Converter	3-4
	3-5. AC - DC Polarity Switch	3-5
IV	MAINTENANCE	4-1
	4-1. General	4-1
	4-2. Periodic Maintenance	4-1
	4-3. Corrective Maintenance	4-1
	4-4. Calibration	4-7
V	LIST OF REPLACEABLE PARTS	5-1
	5-1. General	5-1
	5-2. How To Obtain Parts	5-1
VI	ACCESSORIES	6-1
	6-1. Precision Voltage Dividers	6-1
	6-3. Isolation Amplifier	6-2
	WARRANTY	
	CIRCUIT DIAGRAM	

Digitized by the Internet Archive
in 2025

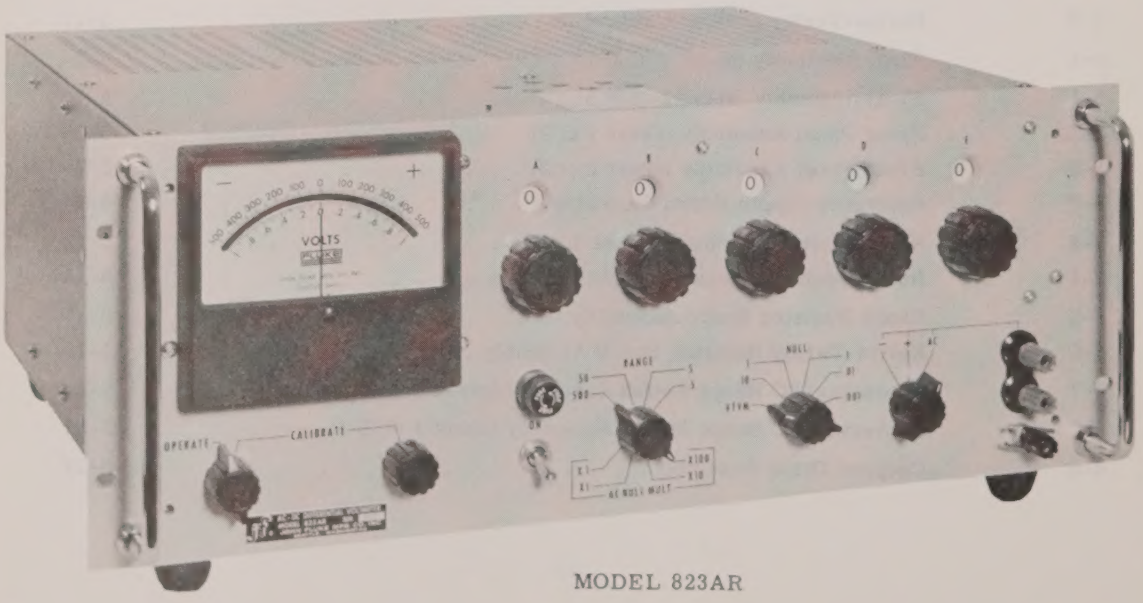
https://archive.org/details/manualsplus_09573

LIST OF ILLUSTRATIONS

Figure	Title	Page
Frontispiece	Model 823A AC/DC Differential Voltmeter	iv
2-1	Controls, Terminals, and Indicators (sheet 1 of 2)	2-1
2-1	Controls, Terminals, and Indicators (sheet 2 of 2)	2-2
2-2	Recommended Null Settings	2-3
2-3	VTVM Ranges	2-4
2-4	Full Scale AC Deflections	2-5
2-5	Percent Error Due to Harmonic Distortion	2-7
2-6	Signal Voltage with Converter Noise	2-8
3-1	823A AC/DC Differential Voltmeter Block Diagram	3-1
3-2	Function of Polarity Switch	3-5
4-1	Troubleshooting (sheet 1 of 2)	4-2
4-1	Troubleshooting (sheet 2 of 2)	4-3
4-2	Tube Voltage Chart	4-4
4-3	Transistor Voltage Chart	4-4
4-4	Kelvin-Varley Divider Checking Setup	4-5
4-5	Kelvin-Varley Error Limits	4-6
4-6	Calibration Equipment	4-8
4-7	Adjustment Locations	4-9
4-8	AC to DC Converter Calibration Setup	4-10
4-9	Kelvin-Varley Divider Calibration	4-11
5-1	Final Assembly (sheet 1 of 2)	5-3
5-1	Final Assembly (sheet 2 of 2)	5-4
5-2	Front Panel Assembly (sheet 1 of 2)	5-6
5-2	Front Panel Assembly (sheet 2 of 2)	5-7
5-3	Reference Supply Board Assembly	5-9
5-4	Null Detector Assembly (sheet 1 of 2)	5-12
5-4	Null Detector Assembly (sheet 2 of 2)	5-15
5-5	Range Resistor Board Assembly	5-17
5-6	Kelvin-Varley Resistor Board Assembly	5-18
5-7	Converter/AC Range Switch Assembly (sheet 1 of 2)	5-21
5-7	Converter/AC Range Switch Assembly (sheet 2 of 2)	5-22
5-8	Chopper Drive Assembly	5-23



MODEL 823A



MODEL 823AR

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

a. This instruction manual is for use with the 823A series AC/DC Differential Voltmeters. The 823A is available in a cabinet model or a model designed to fit a standard 19 inch rack. Rack models are denoted by an "R" immediately following the 823A part of the model number.

b. The high accuracy, portability, and compactness of the 823A make this instrument ideal for the precise measurement of almost any AC or DC voltage. Ease of operation, inherent protection from accidental overload, and high reliability contribute to the outstanding performance that assures suitability for both production line testing and precision laboratory measurements. This instrument is capable of being used as a vacuum tube voltmeter, as a precision potentiometer, and as a megohmmeter for measurement of high resistance. It can also be used to measure the excursions of a voltage about some nominal value. One feature that should be emphasized is that no current is drawn from the unknown source for DC measurements when balance is attained. Thus the determination of the unknown DC potential is independent of its source resistance. The 823A is basically used for measurements of DC voltages from 0 to 500 volts and AC voltages from 0.001 to 500 volts. However, high accuracy measurements to 30,000 volts DC are possible with precision voltage dividers especially designed for use with the Fluke 800 series differential voltmeters. As additional features, this instrument contains a polarity switch for equal convenience in measuring positive or negative DC voltages and an adjustable recorder output which makes the 823A particularly useful for monitoring the stability of almost any AC or DC voltage. Furthermore, the 823A meter has taut-band suspension which eliminates problems due to meter stickiness.

c. When used as a DC differential voltmeter, the 823A operates on the potentiometric principle. An unknown voltage is measured by comparing it to a known adjustable reference voltage with the aid of a null detector. An accurate standard for measurements is obtained by setting the reference supply with a standard cell. The known adjustable reference voltage is provided by a 500 volt DC power supply and five Kelvin-Varley decade resistor strings that are set by five voltage readout dials. In this way, the 500 volts can be precisely divided into increments as small as 10 microvolts. The unknown voltage is then simply read from the voltage dials. When used as an AC differential voltmeter, the 823A operates essentially the same as for DC differential measurements. The AC input voltage is converted to a DC voltage and this DC voltage is measured by comparing it to a known adjustable reference voltage. In the highest recommended null sensitivity range, potential differences between the unknown and the reference voltage of only 0.001 volts for DC and 0.001 volts for AC will cause full scale meter deflection.

d. The instrument is normally supplied ready for use on 115 volts. Upon request, instruments are supplied for 230 volt operation. If it becomes desirable to convert from one mode of operation to the other, refer to the instruction decal on the back of cabinet models or on the cover in rack models.

1-2. DAMAGE IN SHIPMENT

Immediately upon receipt, thoroughly inspect for any damage that may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page at the back of this manual.

1-3. SPECIFICATIONS

AS A PRECISION POTENTIOMETER

DC ACCURACY:

±0.01% of input voltage from 0.5 to 500 VDC
±(0.01% + 10 uv) below 0.5 VDC

AC ACCURACY:

Input Voltage	Basic AC Accuracy		Low Frequency AC Accuracy		High Frequency AC Accuracy	
	30 cps to 5 kc	20 cps to 10kc	10 cps to 20cps	5 cps to 10 cps	10 kc to 20 kc	20 kc to 100 kc
0.5 to 500	±0.1%	±0.15%	±0.5%	±2%	±0.3%	-
0.001 to 0.5	±(0.1% + 25uv)	±(0.15%+25uv)	±(0.5% + 25uv)	±(2% + 25uv)	±(0.3% + 25uv)	-
0.05 to 50	-	-	-	-	-	±1%

RANGE:

For DC Measurements

Input Voltage Range	Null Range	Input Resistance per volt of input voltage	
		At Null	1% of Full Scale Off Null
50-500	10-0-10	Infinite	100 Meg
	1-0-1	Infinite	1,000 Meg
	0.1-0-0.1	Infinite	10,000 Meg
5-50	1-0-1	Infinite	1,000 Meg
	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	100,000 Meg
0.5-5	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	100,000 Meg
	0.001-0-0.001	Infinite	100,000 Meg
0-0.5	0.01-0-0.01	Infinite	100,000 Meg
	0.001-0-0.001	Infinite	100,000 Meg

For AC Measurements

Input Voltage Range	Recommended Null Range	Input Impedance
50-500	100-0-100	1 Meg, 35 uuf
	10-0-10	1 Meg, 35 uuf
	1-0-1	1 Meg, 35 uuf
5-50	10-0-10	1.1 Meg, 35 uuf
	1-0-1	1.1 Meg, 35 uuf
	0.1-0-0.1	1.1 Meg, 35 uuf
0.5-5	1-0-1	1 Meg, 50 uuf
	0.1-0-0.1	1 Meg, 50 uuf
	0.01-0-0.01	1 Meg, 50 uuf
0.001-0.5	0.1-0-0.1	1 Meg, 50 uuf
	0.01-0-0.01	1 Meg, 50 uuf
	0.001-0-0.001	1 Meg, 50 uuf

RESOLUTION:

Voltage Readout Dial Resolution

Range Setting	Null Setting	Resolution
500	any	10 mv
50	any	1 mv
5	any	0.1 mv
0.5	any	0.01 mv

Meter Resolution
(1/4 of a small scale meter division)

Polarity Setting	Range Setting	Null Setting	Resolution
DC	any	10	50 mv
DC	any	1	5 mv
DC	any	0.1	0.5 mv
DC	any	0.01	0.05 mv
DC	any	0.001	0.005 mv
AC	500	1	500 mv
AC	500	0.1	50 mv
AC	50	1	50 mv
AC	500	0.01	5 mv
AC	50	0.1	5 mv
AC	5	1	5 mv
AC	50	0.01	0.5 mv
AC	5	0.1	0.5 mv
AC	0.5	1	0.5 mv
AC	5	0.01	0.05 mv
AC	0.5	0.1	0.05 mv
AC	0.5	0.01	0.005 mv

AS A VACUUM TUBE VOLTMETER

ACCURACY: 3% of full scale

RANGE:

Voltage Ranges		Input Impedance
DC:	500-0-500	50 Meg
	50-0-50	50 Meg
	5-0-5	50 Meg
	0.5-0-0.5	50 Meg
	10-0-10*	10 Meg
	1-0-1*	10 Meg
	0.1-0-0.1*	10 Meg
	0.01-0-0.01*	10 Meg
	0.001-0-0.001*	1 Meg
AC:	0-500	1 Meg, 35 uuf
	0-50	1 Meg, 35 uuf
	0-5	1 Meg, 50 uuf
	0-0.5	1 Meg, 50 uuf
	0-100**	1 Meg, 35 uuf
	0-10**	1 Meg, 35 uuf
	0-1**	1 Meg, 35 uuf
	0-0.1**	1 Meg, 35 uuf
	0-0.01**	1 Meg, 50 uuf
	0-0.001**	1 Meg, 50 uuf

*These ranges are obtained by using Null ranges with all five voltage readout dials set to 0.

**These ranges are obtained by the proper setting of the range and null switches with all five voltage readout dials set to 0.

GENERAL SPECIFICATIONS

REGULATION AND STABILITY OF 500 VOLT SUPPLY:

±0.0025% for a ±10% line change
±0.005% per hour after 30 min. warmup

STABILITY OF METER ZERO:

±0.25% of full scale for a ±10% line change

TERMINAL LINEARITY OF KELVIN-VARLEY DIVIDER:

±0.0002% (2ppm) from 0 to 0.1 of full scale
±0.0002% to ±0.002% (2 ppm to 20 ppm) from 0.1 full scale to full scale

OPERATING TEMPERATURE RANGE:

Model 823A and 823AR (Standard cell reference element).

Within DC accuracy specifications from 55°F to 95°F, derated at 0.0004%/°F outside these limits to 35°F and 110°F.

Within AC accuracy specifications from 55°F to 95°F, derated outside these limits to 35°F and 110°F as follows:

±0.003%/°F up to 10 kcps
±0.005%/°F above 10 kcps

Model 823A/AG and 823AR/AG (Zener diode reference element).

Within DC accuracy specifications from 55°F to 95°F, derated at 0.0005%/°F outside these limits to 0°F and 125°F.

Within AC accuracy specifications from 55°F to 95°F, derated outside these limits to 0°F and 125°F as follows:

±0.003%/°F up to 10 kcps
±0.005%/°F above 10 kcps

STORAGE TEMPERATURE RANGE:

10°F to 130°F

RELATIVE HUMIDITY:

Within specifications from 0 to 80% relative humidity

SHOCK AND VIBRATION:

Meets requirements of MIL-T-945A

INPUT POWER:

115/230 VAC ±10%, 50 - 400 cps, approximately 80 watts

SIZE:

Cabinet: 13" high x 9-3/4" wide x 16" deep
Rack: 7" high x 19" wide x 15-1/2" deep

WEIGHT:

Cabinet: Approximately 27 lbs.
Rack: Approximately 24 lbs.

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

The location, circuit symbol, and a functional description of external controls, terminals, and indicators on the 823A Precision AC/DC Differential Voltmeter may be found in figure 2-1.

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTION DESCRIPTION
Input terminals	Front panel	J1, J2	Provided for connecting AC or DC voltage to be measured.
Chassis ground terminal	Front panel	J3	Provided for grounding purposes. A 0.47 uf capacitor is connected from the lower input binding post to the chassis ground post. The upper input post should never be connected to the chassis ground post. Since the instrument is equipped with a three-wire line cord with the third wire fastened to the chassis, the external circuit should be checked for conflicts in grounding before connecting lower input binding post (middle post) to the chassis post.
Power toggle switch	Front panel	S1	Applies AC line voltage to the primary circuit of the power transformer.
OPERATE-CALIBRATE switch	Front panel	S4	Remains in the OPERATE position at all times except when it is necessary to calibrate the internal 500 volt DC reference supply. When held in the CALIBRATE position, a representative sample of the reference voltage is compared to the voltage of an internal standard cell and any difference is indicated on the meter.
CALIBRATE control	Front panel	R12	Varies the output of the 500 volt DC reference supply. When the OPERATE-CALIBRATE switch is held in the CALIBRATE position, the reference supply is accurately set by adjusting the CALIBRATE control for zero meter deflection.
RANGE switch	Front panel	S2	Selects desired voltage range. Full scale voltage ranges of 500, 50, 5, and 0.5 volts are available. It also indicates the AC NULL MULT for each range position.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS (sheet 1 of 2)

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
NULL switch	Front panel	S3	Set to VTVM for determining the approximate value of unknown voltage prior to differential measurements. Five null switch ranges of 10, 1, 0.1, 0.01, and 0.001 volts are used for differential measurements. For the DC mode, the null ranges represent full scale differences between the unknown voltage and the amount of precision internal reference voltage that is set on the voltage readout dials. For the AC mode, the null range used times the applicable AC Null Multiplier, indicated by the range switch, represents the full scale difference between the unknown voltage and the amount set on the voltage dials.
A, B, C, D, and E voltage readout dials	Front panel	S6, S7, S8, S9, S10	Provide an in-line readout of the amount of internal reference voltage necessary to null the unknown voltage.
Decimal lights	Front panel	DS1, DS2, DS3, DS4	Serve as decimal points for the voltage readout dials. A different light illuminates for each position of the RANGE switch.
AC - DC polarity switch	Front panel	S5	Selects the AC, + DC, or - DC mode of operation. With this switch in the positive position, the polarity of the upper input binding post is positive with respect to the lower input binding post (middle post).
Output terminals	Rear panel	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
Output level control	Rear panel	R1	Varies the output level of the output binding post from 0 to at least 18 millivolts full scale deflection.
Meter	Front panel	M1	Indicates approximate voltage when 823A is in VTVM mode and difference between unknown and internal reference voltage when 823A is in differential mode. The upper scale, 500-0-500, is used when the NULL switch is set to VTVM at all other times, the lower scale, 1-0-1, is used.
Mechanical zero control	Meter case	None	Sets meter to zero mechanically. This adjustment should be used only after instrument has been turned off for at least three minutes or when the internal meter terminals have been shorted.
Fuse	Rear panel of cabinet models, front panel of rack models	F1	Fuse holder protrudes from instrument to provide easy access to the fuse. The fuse is a 1.5 ampere slow blowing type for 115 volt operation and a 0.75 ampere slow blowing type for 230 volt operation.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS (sheet 2 of 2)

2-2. ZEROING INSTRUCTIONS

From time to time, it may be necessary to adjust the internal meter zero control. This will normally be done at somewhat more frequent intervals than regular calibration for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326. For later instruments, it should only be necessary to adjust the internal meter zero during regular calibration. Proceed as follows:

a. Mechanically zero the meter with the adjustment screw on the front of the meter case. If the instrument is in the case, it must be shut off for at least three minutes prior to this adjustment. If out of case, another method would be to short out the internal meter terminals prior to zeroing.

b. Set power switch to ON and allow a 20 minute warmup period.

c. Set RANGE switch to 5 or 0.5 volts, voltage readout dials to zero, and NULL switch to VTVM.

d. Adjust R212 (R232 for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 825AR/AG serial numbers 123 to 326), null detector ZERO ADJ, for zero meter deflection. This control may be reached through the ventilation holes in the cabinet model (see figure 4-7). In the rack model, an identified access hole is provided on the rear panel. An insulated screwdriver must be used to reach the control. This is done to prevent shorting control to chassis ground.

2-3. PRELIMINARY OPERATION

The following procedure prepares the voltmeter for operation:

a. Connect power plug to a 115 volt AC power source. If instrument has been wired for 230 volt operation, connect to 230 volts AC.

NOTE

The round pin on polarized three-prong plug connects instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact receptacle. For personnel safety, connect short lead to a suitable ground.

b. Set controls on 823A voltmeter as follows:

RANGE	500 volts
NULL	VTVM
AC - DC polarity	+ (positive)
all voltage readout dials	0 (zero)
power	ON

c. After a warmup period of at least ten minutes, advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE, and adjust internal 500 volt DC reference supply with CALIBRATE control for zero meter deflection. Release OPERATE-CALIBRATE switch.

2-4. OPERATION AS A DC DIFFERENTIAL VOLTMETER

a. After completing preliminary operation, connect unknown voltage to input binding posts. If one side is grounded, always connect it to the lower input post (middle post).

b. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on upper meter scale.

c. If meter reads to the left, turn AC - DC polarity switch to the negative position. The meter needle will deflect to the right. This is because polarity of unknown voltage is negative.

d. Noting the position of illuminated decimal light, set five voltage readout dials to approximate voltage determined in step b. For example, if approximate voltage is 35 volts, the decimal light between the B and C voltage readout dials will be illuminated. Therefore, set A dial to 3, B dial to 5, and C, D, and E dials to 0.

e. Set NULL switch to successively more sensitive null ranges, as indicated in figure 2-2, and adjust voltage readout dials for zero meter deflection in each null position. When the meter needle indicates to the right, the voltage under measurement is greater than the voltage set on the voltage readout dials. When the indication is to the left, the voltage is less than that set on the readout dials.

f. Read unknown voltage directly from the five voltage readout dials.

INPUT VOLTAGE RANGE	*RECOMMENDED NULL SETTING
50-500	10 then 1 (then 0.1 for voltages from 50 to 100 volts)
5-50	1 then 0.1 (then 0.01 for voltages from 5 to 10 volts)
0.5-5	0.1 then 0.01 (then 0.001 for voltages from 0.5 to 1 volt)
0-0.5	0.01 then 0.001
*Any null range may be used with any input voltage range; recommended settings are those most useful.	

Figure 2-2. RECOMMENDED NULL SETTINGS

2-5. OPERATION AS AN AC DIFFERENTIAL VOLTMETER

a. After completing preliminary operation, set AC-DC polarity switch to AC.

b. Connect unknown AC voltage to input binding posts.

c. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on upper meter scale.

d. Noting the position of illuminated decimal light, set five voltage dials to approximate voltage determined in step c. For example, if approximate voltage is 35 volts, the decimal light between the B and C voltage dials will be illuminated. Therefore, set A dial to 3, B dial to 5, and C, D, and E dials to 0.

e. Set null switch to 0.1 and then 0.01 volt, adjusting voltage dials for zero meter deflection in each position.
f. Read unknown voltage from the five voltage readout dials.

2-6. OPERATION AS A CONVENTIONAL VTVM

If it is desired to use the instrument as a VTVM only, additional ranges can be made available by converting the NULL ranges to VTVM ranges. This is made possible by setting the voltage readout dials to zero. Proceed as follows:

a. Perform preliminary operation procedures as stated in paragraph 2-3.
b. Consult figure 2-3, and select full scale voltage deflection desired. If the approximate value of the voltage to be measured is unknown, select the 500 volt range initially.
c. Set AC - DC polarity switch, RANGE switch, NULL switch, and voltage dials as indicated for the range selected.
d. Connect voltage to be measured to input binding posts. Deflection to the right indicates that an unknown DC voltage is of positive polarity. An unknown AC voltage will always cause deflection to the right.
e. Read voltage from upper or lower scale as listed in figure 2-3.

2-7. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

a. After completing preliminary operation as stated in paragraph 2-3, set AC - DC polarity switch to desired position.
b. Connect voltage to be observed to input binding posts. If meter reads to the left, the voltage being measured is negative DC; set polarity switch to the negative position in this case. This will cause meter pointer to deflect to the right.
c. Set RANGE switch to lowest range which will give an on-scale meter indication and note nominal value of voltage indicated.
d. Set the five voltage readout dials to nominal voltage.
e. Turn NULL switch to lowest position that will allow voltage excursions to remain on scale.
f. Read voltage excursions from meter. Note that full scale right and left meter deflections are equal to the NULL voltage setting for DC measurements. For AC measurements, full scale right and left meter deflections are equal to the NULL voltage setting multiplied by the AC NULL MULT indicated by the RANGE setting. Figure 2-4 shows full scale AC deflections for the recommended settings of the range and null switches.

Full-Scale Deflection	AC-DC Polarity Switch	Range Switch	Null Switch	Voltage Readout Dials	Meter Scale
DC:					
500-0-500	+	500	VTVM	No effect	Upper
50-0-50	+	50	VTVM	No effect	Upper
5-0-5	+	5	VTVM	No effect	Upper
0.5-0-0.5	+	0.5	VTVM	No effect	Upper
10-0-10	+	No effect	10	All zero	Lower
1-0-1	+	No effect	1	All zero	Lower
0.1-0-0.1	+	No effect	0.1	All zero	Lower
0.01-0-0.01	+	No effect	0.01	All zero	Lower
0.001-0-0.001	+	No effect	0.001	All zero	Lower
AC:					
0-500	AC	500	VTVM	No effect	Upper
0-50	AC	50	VTVM	No effect	Upper
0-5	AC	5	VTVM	No effect	Upper
0-0.5	AC	0.5	VTVM	No effect	Upper
0-100	AC	500	1	All zero	Lower
0-10	AC	500	0.1	All zero	Lower
		50	1		
0-1	AC	500	0.01	All zero	Lower
		50	0.1		
		5	1		
0-0.1	AC	50	0.01	All zero	Lower
		5	0.1		
		0.5	1		
0-0.01	AC	5	0.01	All zero	Lower
		0.5	0.1		
0-0.001	AC	0.5	0.01	All zero	Lower

Figure 2-3. VTVM RANGES

Range Switch Setting	Null Switch Setting	AC Null Multiplier	Full Scale AC Deflection (in volts)
500	1 0.1 0.01	X100	100 10 1
50	1 0.1 0.01	X10	10 1 0.1
5	1 0.1 0.01	X1	1 0.1 0.01
0.5	1 0.1 0.01	X0.1	0.1 0.01 0.001

Figure 2-4. FULL SCALE AC DEFLECTIONS

2-8. RECORDING VOLTAGE EXCURSIONS

a. GENERAL. Recorder output binding posts and an output level control are provided on the 823A for monitoring the excursions of an unknown voltage from the voltage indicated by the voltage readout dial settings. If the leakage resistance between the recorder and ground is less than 10,000 megohms, the accuracy of the voltmeter will be impaired. Therefore, the FLUKE Model A88 Isolation Amplifier is recommended for this application. The A88 will allow the use of a wide range of strip chart recorders for recording the voltmeter reading without regard to the input isolation characteristics of the recorder.

b. USE OF 823A WITH A88 AND A RECORDER. To use the A88 Isolation Amplifier and a recorder with the 823A, proceed as follows:

(1) Set A88 POWER switch to ON.

(2) When batteries are being used as a power source for A88, measure voltage at BATT TEST jacks. If voltage is between 11.7 and 14 volts DC, the batteries are satisfactory for use. However, if battery voltage is below 12.8 volts, batteries are approaching end of their useful life and should be replaced.

(3) Connect output terminals of differential voltmeter to INPUT terminals of isolation amplifier with teflon leads.

(4) Connect OUTPUT terminals of isolation amplifier to recorder input terminals.

(5) Perform preliminary operation as stated in paragraph 2-3.

(6) Short input terminals of 823A and set switches on 823A as follows:

AC - DC polarity	+(positive)
RANGE	50
NULL	10
voltage readout dials	10.000

The 823A meter will indicate full scale. This provides up to a maximum of at least 18 millivolts at the output terminals depending on setting of the output level control.

(7) Turn on recorder and set recorder gain so that a recorder input of either ±2 volts or near maximum if maximum is below ±2 volts will cause recorder deflection desired for full scale deflection of differential voltmeter.

(8) Adjust output level control on differential voltmeter until recorder deflection obtained is that desired to correspond to full scale deflection of the differential voltmeter.

(9) Remove short from input terminals of the 823A. The voltmeter and recorder are now ready for recording the measurement of voltage excursions about a nominal value. Proceed as instructed under paragraph 2-7.

c. USE OF 823A WITH A RECORDER. To use a recorder with the 823A, proceed as follows:

(1) Connect 823A output terminals to input terminals of recorder with teflon leads.

CAUTION

Do not ground either of the 823A recorder output terminals or either of the recorder input terminals. If any of these terminals are grounded, current will be drawn from the 823A Kelvin-Varley voltage divider and the 823A will no longer be accurate.

(2) After connecting the recorder, perform preliminary operation as stated in paragraph 2-3.

(3) Check for excessive leakage as follows:

(a) Connect a DC voltage to the input of the 823A and differentially measure its potential in a recommended null range.

(b) Alternately connect and disconnect the recorder leads from the output terminals of the 823A while noting the meter needle deflection. More than one-quarter of a small scale division deflection indicates that excessive leakage has been introduced by the recorder. This will impair the accuracy of the 823A voltmeter.

(c) Disconnect the voltage.

(4) After the leakage test has been successfully completed, short input terminals of 823A.

(5) Set switches on 823A voltmeter as follows:

AC - DC polarity	+ (positive)
RANGE	50
NULL	10
voltage readout dials	10.000

The 823A meter will indicate full scale deflection. This provides up to at least 18 millivolts at the output terminals depending on the setting of the output level control.

(6) Turn output level control until recorder deflection obtained is that desired to correspond to full scale deflection of 823A.

(7) Remove short from input terminals of 823A. The 823A and recorder are now ready for combined use. Proceed as instructed under paragraph 2-7.

2-9. MEASUREMENT OF HIGH RESISTANCES

One of the important features of the 823A voltmeter is its ability to be used as a megohmmeter for rapidly measuring high resistances from .1 megohm to 250,000 megohms. The following equation may be used to compute the resistance in megohms of an unknown connected to the input binding posts:

$$R_x = 10\left(\frac{E}{E_m} - 1\right) \text{ megohms,}$$

where:

R_x = unknown resistance in megohms

E = voltage indicated by voltage readout dials

E_m = voltage indicated on meter

10 = megohms of input resistance of VTVM circuit on 10, 1, and 0.1 null range.

When connecting the unknown resistance to the input terminals, use short isolated leads to prevent measuring leakage resistance between the leads.

a. FROM 1 MEGOHM TO 500 MEGOHMS. For rapid measurement of resistances from 1 megohm to 500 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 10.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 10.00 from the amount set on the voltage readout dials to find the resistance of the unknown in megohms.

b. FROM 500 MEGOHMS TO 5,000 MEGOHMS. For rapid measurement of resistances from 500 to 5,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 1.00 from the amount set on the voltage readout dials and multiply the result by 10 to find the resistance of the unknown in megohms.

c. FROM 5,000 MEGOHMS TO 50,000 MEGOHMS. For rapid measurement of resistances from 5,000 to 50,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Multiply the amount set on the voltage readout dials by 100 to find the resistance of the unknown in megohms.

d. FROM 50,000 MEGOHMS TO 250,000 MEGOHMS. To determine the value of an unknown resistance between 50,000 megohms and 250,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for a convenient meter deflection.

(5) The resistance in megohms may be calculated by substituting the meter reading in volts (E_m, 0 to 0.1 volt on bottom scale) and the voltage readout dial setting (E) into the following equation:

$$R_x = 10\,\frac{E}{E_m} \text{ megohms}$$

2-10. NOTES ON MEASURING AC OR DC VOLTAGES

a. ADJUSTMENT OF 500 VOLT REFERENCE SUPPLY. The 500 volt DC reference supply may be adjusted (paragraph 2-3, step c) at any time deemed necessary without heed to the position of the switches and without removing any input or output connections. However, until the instrument has warmed up to an equilibrium temperature (about 1/2 hour), it should be adjusted prior to each specific measurement for best accuracy. When making prolonged measurements, allow one hour warmup time to insure that 500 volt reference supply does not shift during the final warmup phase.

b. GROUND LOOP PRECAUTIONS. Ground loop currents should be avoided to assure accuracy when making measurements. Potential differences are often found at different points on power system grounds. When this is the case, current may flow from the power system ground through the 823A and the equipment under measurement and back to the power system ground. To avoid this when system being measured is grounded, do not connect shorting link from lower input binding post to chassis ground post.

c. USE OF SHORTING LINK. A 0.47 uf capacitor (C1) is connected from the lower input binding post to the chassis ground post to reduce the effect of circulating AC currents from the transformer. In some cases, it is possible for C1 to acquire a charge. For example, C1 will become charged through leakage resistance over a period of time if there is no external connection to the input terminals and the controls are set as follows: range to 500, null to any null range, polarity to +, and voltage readout dials to several hundred volts. This condition may cause an error on low level measurements (under 5 volts) due to C1 discharging through the Kelvin-Varley divider. Connecting the shorting link from the lower input post to the ground post will discharge C1 and thus prevent an inaccurate indication.

2-11. NOTES ON MEASURING DC VOLTAGES

a. RECOMMENDED NULL RANGES FOR DC MEASUREMENTS. Certain null ranges are recommended for use with each setting of the RANGE switch for the following reasons. With the RANGE switch at 500 volts the last voltage readout dial (E) changes the reference voltage in steps of 0.01 volt. Therefore, the unknown voltage would have to be an exact multiple of 0.01 volt if a null is to be obtained on the 0.1 or 0.01 volt NULL range. Furthermore, it is unlikely that an unknown voltage of a few hundred volts will be stable within 10 millivolts. Finally, the regulation of the reference supply is approximately ±0.0025% (±0.0125 volt) for a 10% change in line voltage. Although this is more than adequate when the instrument is used in the recommended way, a badly fluctuating line voltage may cause the 823A to meter the regulation of its own 500 volt reference supply. For example, when measuring 500 volts a line change of 10% may cause the 500 volt reference supply to change as much as 12.5 mv. Although this is small, the 823A will indicate full scale for a change as little as 100 mv or 10 mv if attempting to use the 0.1 or 0.01 null ranges.

b. EFFECT OF AC COMPONENTS ON DC MEASUREMENTS. An AC component of several times the unknown DC may be present on the unknown and the 823A will always indicate well within the specifications for frequencies over a few hundred cycles. An AC component may have an adverse effect if it is of a low frequency or if it has a frequency that is a multiple or submultiple of the chopper frequency. A double section low pass filter (R201, C201, R202, and C202) is used at the input of the null detector to reduce any AC present on the DC being measured. At lower frequencies, this low pass filter is less effective and the magnitude of the AC component is more significant. If this frequency is below 100 cycles, the accuracy may no longer be with specifications. For example, a 60 cycle AC voltage that is 1% of the input voltage will cause an error of approximately 0.001% which is well within the specifications. Also, since the input attenuation is less for the more sensitive null settings, the accuracy may be affected only on the more sensitive null settings. When the frequency is very close to a multiple or submultiple of the chopper frequency (approximately 83 cycles), the meter needle will oscillate at the difference frequency. If AC components that affect the accuracy are ever encountered, additional filtering will be required. For an AC of a single frequency, a twin-T filter is effective and has the advantage of low total series resistance. For an AC variable frequency, an ordinary low pass filter may be used. In either case, high quality capacitors of high leakage resistance should be used.

c. MEASUREMENT OF NEGATIVE DC VOLTAGES. Because of a polarity switch, voltages which are negative with respect to ground as well as the more commonly encountered positive voltages may be measured with equal facility. If the upper input post is connected to the metal case or line ground, either at the 823A or at the source under measurement, the accuracy of the voltmeter may be reduced. However, with the polarity switch the upper input post never has to be connected to ground. If the unknown voltage is grounded, always connect the grounded side to the lower input post (middle post) and use the polarity switch to obtain the proper result.

2-12. NOTES ON MEASURING AC VOLTAGES

a. ERRORS DUE TO DISTORTION. The AC to DC converter in the 823A is an average measuring device calibrated in RMS. The converter will put out a DC voltage that is proportional to 1.11 times the average value of the AC input voltage. Thus, if the input signal is not a true sinusoid, the 823A reading is probably in error because the ratio of RMS to average is usually not the same in a complex wave as in a sine wave. The magnitude of the error is dependent on magnitude of the distortion and on its phase and harmonic relationship with respect to the fundamental. Figure 2-5 indicates how the accuracy will be affected by various harmonics for different percentages of distortion. If the distortion present in the signal is composed of even harmonics and is less than 2%, the error between the 823A reading and true RMS is fairly minor. A larger error can occur if the distortion is composed of odd harmonics, especially the third harmonic. Note that for 2% of third harmonic distortion the error in the reading could range from 0 to 0.687%.

Harmonic	% Distortion	% Error From True RMS*	
		Maximum Positive	Maximum Negative
Any even harmonic	0.1	0.000	0.000
	0.5	0.000	0.0001
	1.0	0.000	0.005
	2.0	0.000	0.020
Third harmonic	0.1	0.033	0.033
	0.5	0.167	0.168
	1.0	0.328	0.338
	2.0	0.667	0.687
Fifth harmonic	0.1	0.020	0.020
	0.5	0.099	0.101
	1.0	0.195	0.205
	2.0	0.380	0.420

*Error depends upon phase relationship between harmonic and fundamental, i. e. error can be any value between maximum positive and maximum negative, including zero.

Figure 2-5. PERCENT ERROR DUE TO HARMONIC DISTORTION

b. ERRORS DUE TO GROUNDING. In the 823A there is a 0.47 uf capacitor connected from the lower input terminal (middle post) to chassis ground. If it is desired to make measurements where the voltage to be connected to the lower input terminal is not at ground potential, a line cord adapter must be used to isolate the 823A chassis from line ground. Otherwise, the 0.47 uf capacitor would place an AC load on the circuit being measured.

c. INTERNAL CONVERTER NOISE. When the instrument is shorted in the AC mode, the converter may produce a residual noise output of approximately 100 uv. This noise voltage will cause an insignificant error as long as AC input signals of 1 mv or larger are applied to the instrument. Figure 2-6 shows a typical half wave of the signal voltage at the output of the converter amplifier. It is easily seen that the noise contributes very little to the average value of the signal and is well within the 2.6% accuracy of the instrument at 1 mv.

d. 0.001 VOLT NULL RANGE ON AC. The 0.001 volt null range should be used with caution when measuring AC voltages. Most AC sources are not stable enough to be used on this range. For example, if 0.5 volt is measured with the range switch set to 0.5 and the null switch set to 0.001, the effective null detector sensitivity is 100 microvolts full scale. Since 100 uv is 0.02% of 0.5 volt, an AC source with a stability worse than ±0.02% will cause the 823A meter pointer to swing from one end of the meter to the other. Also, if the input is shorted with the range switch set to 0.5 and the null switch set to 0.001, the meter needle may deflect more than full scale due to converter noise. However, as pointed out in paragraph 2-12c, converter noise will not impair the accuracy for input signals greater than 1 mv. Thus, any excessive erratic meter needle movement is due to AC source stability.

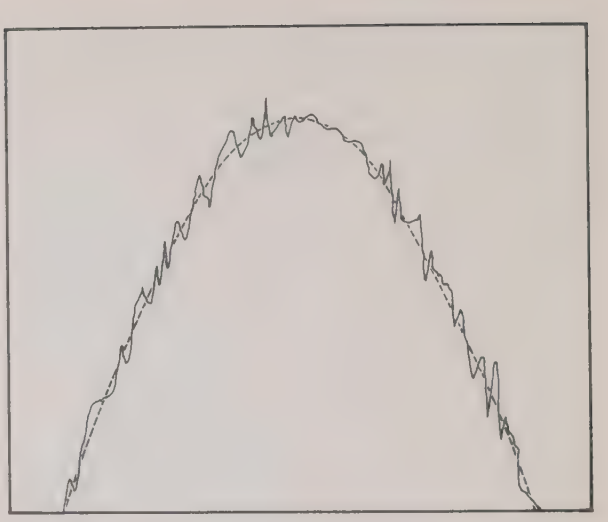


Figure 2-6. SIGNAL VOLTAGE WITH CONVERTER NOISE

SECTION III

THEORY OF OPERATION

3-1. GENERAL

a. Figure 3-1 shows the block diagram for the 823A AC/DC Differential Voltmeter. As seen in this figure, the circuit consists basically of an AC to DC converter, a DC vacuum tube voltmeter (vtvm), and a 0 to 500 volt DC reference. Refer to the functional schematic following section VI for more detail. This schematic is designed to aid in the understanding of circuit theory and troubleshooting. The signal flow is from left to right and the components are laid out in a functionally logical manner.

b. The overall operation of the 823A may be summarized as follows. To measure the approximate value of a DC voltage, the unknown voltage is connected directly to the DC vtvm. To accurately measure a DC voltage, the unknown voltage is connected across the series combination of the DC vtvm and the 0 to 500 volt DC reference. The reference voltage is then adjusted with the five voltage readout dials until it matches the unknown voltage as indicated by the vtvm. All AC measurements are made by first converting the AC input voltage to a DC voltage by means of the AC to DC converter. The 823A then operates essentially the same as for approximate and accurate DC measurements.

c. In order to provide for a more complete understanding of the 823A voltmeter, the following paragraphs describe each section of the circuit in detail.

3-2. DC VACUUM TUBE VOLTMETER

a. GENERAL. The DC vtvm is composed of an attenuator, a null detector, and a meter. The heart of the DC vtvm is the null detector in which the DC signal input is modulated, amplified, rectified, and finally filtered to produce a DC output. The chopper amplifier has a high amount of negative current feedback. This makes the

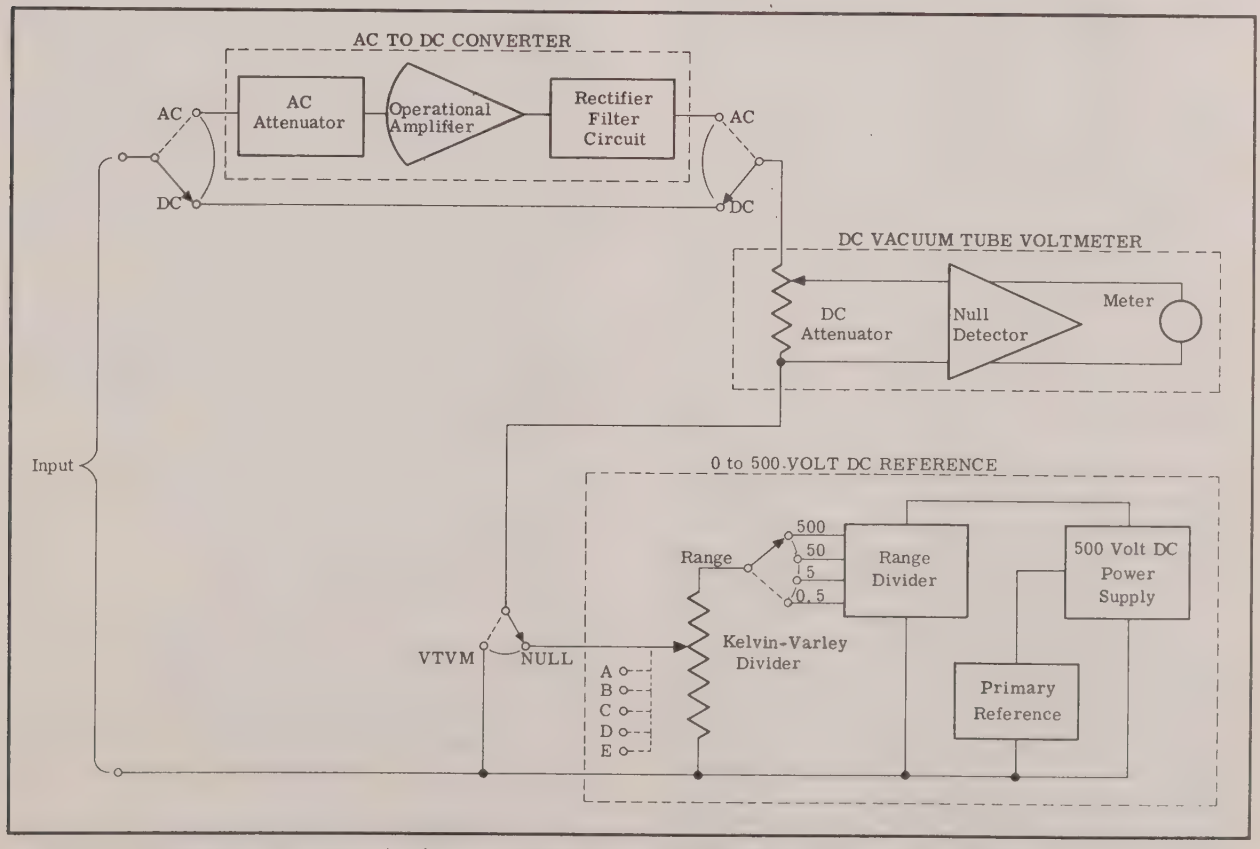


Figure 3-1. 823A AC/DC DIFFERENTIAL VOLTMETER BLOCK DIAGRAM

output current approximately equal to the signal voltage divided by the impedance of the feedback network, regardless of the amplifier characteristics. The high negative feedback also makes the amplifier relatively insensitive to the gain changes in individual stages due to aging and replacement. The output current from the null detector is indicated on a meter that has taut-band suspension. This suspension does away with all friction associated with meter pivot stickiness. Thus, any tendency for the meter pointer to stick at one point of the scale and then jump to another point is eliminated. The attenuator is used to reduce the voltage span of each range to a common range usable by the null detector to produce proper meter deflection.

b. NULL DETECTOR FOR 823A & 823A/AG SERIAL NUMBERS 123 TO 502 AND 823AR & 823AR/AG SERIAL NUMBERS 123 TO 326. At the input to the null detector, R201, C201, R202, and C202 form a double section low pass filter that reduces any AC component present on the DC voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across the feedback network is converted to an alternating voltage by G1, an 83 cycle electromechanical chopper. This chopped voltage is amplified by V202A, V202B, and V203A before passing through cathode follower V203B. During half the chopper cycle the output of the amplifier is clamped to approximate null detector common potential by G1 while during the other half the output is filtered by C212 to provide a DC current for the meter. The voltage developed across feedback network R220, R221, and R222 is proportional to the meter (output) current. When the chopper provides connection between contacts 5 and 7, this feedback voltage effectively reduces the magnitude of the voltage that is chopped and applied to the input of the amplifier. The impedance of the feedback network (R220, R221, and R222) is adjustable between 8.82 and 9.83 ohms. Since the output current is approximately equal to the signal voltage divided by the impedance of the feedback network, a 1 mv signal voltage indicates an output current of 101.7 to 113.4 ua. However, there is a loss due to finite amplifier gain and filtering that leaves the output current around 100 ua which can be set accurately by means of the feedback network. Thus, current feedback makes the output current essentially proportional to the signal voltage. For full scale deflection, a 1 mv signal voltage will cause 100 ua to flow through the meter.

c. NULL DETECTOR FOR 823A & 823A/AG SERIAL NUMBERS 503 & ON AND 823AR & 823AR/AG SERIAL NUMBERS 327 AND ON. At the input to the null detector, R201, C201, R202, and C202 form a double section low pass filter that reduces any AC component present on the DC voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across the feedback network is converted to an alternating voltage by V201 and V202, a series-shunt photochopper. The photochoppers are driven by an astable multivibrator operating at 84 cycles to prevent interference from line frequency pickup. The chopped voltage is amplified by solid state amplifier Q201 through Q205 before being delivered to demodulator photocell V203. During half the chopper cycle, the output of the amplifier is clamped close to null detector common potential by V203 while during the other half the output is filtered by R221 and C211 to provide a DC output. To prevent loading of the chopper amplifier, especially at high temperatures, the filtered output is fed to unity gain amplifier Q206 and Q207 which supplies the necessary meter current. The voltage developed across feedback network R203, R204, and R205 is proportional to the meter (output) current. When DS202 illuminates V202, its resistance drops from about 50M to 5K and the amplifier input is equal to the feedback voltage. When DS203 illuminates V201, its resistance drops from about 50M to 5K and the amplifier input is equal to the output voltage of the input filter. The impedance of the feedback network (R203, R204, and R205) is adjustable between 9.28 and 10.5 ohms. Since the output current is approximately equal to the signal voltage divided by the impedance of the feedback network, a 1 mv signal voltage indicates an output current of 95.1 to 108 ua. The output current is adjusted to 100 ua during calibration by means of the feedback network. Thus, current feedback makes the output current essentially proportional to the signal voltage. For full scale deflection, a 1 mv signal voltage will cause 100 ua to flow through the meter.

d. INPUT ATTENUATOR. In the DC vtvm mode, four positions on the vtvm attenuator selected by range switch section S2C provide the necessary reduction of the 500, 50, 5, and 0.5 volt ranges for proper null detector input. For this mode, the resistance of the attenuator and thus the input resistance of the 823A is 50 megohms (R301 through R310). In the DC differential mode, the voltage difference (unknown voltage minus reference voltage) is reduced by four positions on the vtvm attenuator selected by null switch section S3C and S3D to give full scale deflections corresponding to inputs of 10, 1, 0.1, and 0.01 volts. For full scale deflection corresponding to 0.001 volt, the voltage across the attenuator is fed directly to the null detector. Although the resistance of the vtvm attenuator is 10 megohms (R6 through R11) for the 10, 1, 0.1, and 0.01 volt null ranges and 1 megohm (R7 through R11) for the 0.001 volt null range; this is not the input resistance of the 823A. The input resistance is determined by dividing the unknown terminal voltage by the current drawn from the unknown. The current drawn from the unknown is equal to the difference between the unknown terminal voltage and the internally known voltage divided by the resistance of the input attenuator. The equation for input resistance can be hence written as:

$$R_{in} = \frac{E_u}{I_u} = \frac{E_u R_a}{|E_u - E|} = \frac{E_S (R_a + R_S)}{|E_S - E|} - R_S$$

where:

R_{in} = input resistance of voltmeter

E_u = $E_S - I_u R_S$ = terminal voltage of unknown

I_u = current drawn from unknown

E_S = source voltage of unknown

R_S = source resistance of unknown

R_a = resistance of input attenuator

E = voltage indicated by voltage readout dials

$| \; |$ = absolute value (magnitude only)

Since the reference voltage (E) is equal to the unknown voltage (E_u) and the source voltage (E_s) at null, no current is drawn from the unknown and the input resistance is therefore infinite.

e. In the AC vtvm mode, null switch sections S3C and S3D and AC - DC switch section S5H (S5F for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823 AR/AG serial numbers 123 to 326) provide connection to only one position on the vtvm attenuator regardless of where the range switch is set. This is because the output of the AC to DC converter is 5 volts DC for full input on each range. In the AC differential mode, the voltage difference (converter output voltage minus reference voltage) is reduced by the same positions on the vtvm attenuator as for DC differential measurements. Because of this and the fact that the converter puts out 5 volts DC for full input on each range, the null range used must be multiplied by the AC null multiplier indicated by the range switch to find the full scale difference between the unknown voltage and the reference voltage. The input impedance for the AC vtvm and AC differential mode depends on the input impedance of the AC to DC converter and its attenuator. The input impedance is thus dependent on the setting of the range switch and is 1 megohm 35 uuf for the 500 volt AC range, 1.1 megohm 35 uuf for the 50 volt AC range, and 1 megohm 50 uuf for the 5 and 0.5 volt AC ranges.

f. NULL DETECTOR POWER SUPPLY FOR 823A & 823A/AG SERIAL NUMBERS 123 TO 502 AND 823AR & 823AR/AG SERIAL NUMBERS 123 TO 326. The B+ supply for the null detector is obtained from a half-wave rectifier consisting of diode CR201 and a filter network (C213A, R227, and C213B) that is regulated by an OA2 tube (V204) and series dropping resistor R230. Divider resistors R228, R229, R231, and R232 and diode CR202 provide a compensating voltage for the purpose of adjusting the null detector to zero with R232 when there is no signal input. Diode CR202 keeps one side of R232 at approximately -0.6 volts DC with respect to the null detector common.

g. The filament of V202 and the chopper drive unit require a stable supply. This is obtained by using a filtered half-wave rectifier (CR203 and C214) that drives a Darlington connection of Q201 and Q202. A divider string R234 and R235 uses the B+ supply to obtain approximately 11.8 volts for pin-5 of V202 while pin-4 is maintained approximately 0 volts through the emitter-base junctions of Q201 and Q202. Any change in the half-wave rectifier voltage causes a corresponding change in the voltage across the emitter-collector junction of Q201 so that the filament and chopper voltage remain stable. The filament supply for V203 is obtained from an ordinary 6.3 volt AC winding.

h. NULL DETECTOR POWER SUPPLY FOR 823A & 823A/AG SERIAL NUMBERS 123 TO 502 AND 823AR & 823AR/AG SERIAL NUMBERS 123 TO 326. The +18 volt and -18 volt supply for the null detector is obtained from a center tapped voltage doubler consisting of R229, CR202, CR203, C213, and C214.

i. EFFECT OF AC COMPONENTS. The only AC voltage component that will reduce the accuracy of the 823A is one that either saturates the chopper amplifier or one that beats with the chopper frequency. Since the voltage required for saturation is greater than that required for beating, the null detector is most sensitive to an AC component with a frequency that is a submultiple or a low multiple of the chopper frequency. However, this is easy to detect because the meter will beat at the difference frequency. The low pass filter at the input of the chopper amplifier will attenuate any AC component. The magnitude of the AC voltage appearing at the output of the filter depends on both is amplitude and frequency before filtering. For all practical purposes, one should never encounter any trouble above a hundred cycles. Below this, the filter may not attenuate the AC component enough. However, this is not as bad as it appears. A 60 cycle AC voltage that is 1% of the input voltage will cause an error of approximately 0.001% which is well within specifications. If AC components that affect accuracy are ever encountered, additional filtering as set forth in paragraph 2-11 will eliminate the problem.

j. GAIN AND ZERO ADJUSTMENTS. For 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326, variable resistor R232 in the null detector power supply provides a means of adjusting the output current of the amplifier to zero when there is no input signal. For later instruments, variable resistor R212 provides a means of adjusting the output current of the amplifier to zero when there is no input signal by utilizing the negative bias voltage on the emitter of Q201 and the positive bias voltage on the emitter of Q205. The gain of the amplifier is adjusted by means of R205 (R222 for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326) in the feedback circuit.

k. RECORDER OUTPUT. The recorder output is picked off divider string R224, R1, and R225 (R225, R1, and R226 for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326). Output level control R1 provides a means of adjusting the output voltage up to a maximum of at least 18 millivolts at full scale deflection. The voltage at the output terminals is proportional to the meter reading.

3-3. 0 TO 500 VOLT REFERENCE

a. GENERAL. When the 823A is used for differential voltage measurements, an internal voltage is nulled or matched against the unknown voltage. An extremely accurate reference voltage is therefore required. This is obtained from the 0 to 500 volt reference. The 0 to 500 volt reference is composed of a well regulated 500 volt power supply, a range divider, and a Kelvin-Varley five decade attenuator. The output of the 500 volt power supply is applied directly to the Kelvin-Varley attenuator for the 500 volt DC range. In the 50, 5, and 0.5 volt DC ranges, the range divider reduces the voltage to 50, 5, and 0.5 volts before it is applied to the Kelvin-Varley attenuator. For any AC range, the range divider always reduces the voltage to 5 volts. The Kelvin-Varley attenuator divides its input voltage (500, 50, 5, or 0.5 volts) into 50,000 equal increments any number of which may be selected by setting the five decades with the voltage readout dials. The output of the Kelvin-Varley attenuator, therefore, provides an extremely accurate reference voltage.

b. 500 VOLT POWER SUPPLY. The 500 volt power supply uses three diodes (CR101, CR102, and CR103) and a filter network (R109, R110, C101, and C102) to supply unregulated DC voltage to series passing tube V101. The voltage is regulated by comparing a sample of the output voltage tapped off a divider string (R123, R124, R121, and R12) with the voltage from reference tube V102 in differential amplifier V104. The output of V104 is fed to differential amplifier V105 which drives the grid of series passing tube V101. The control action of the differential amplifiers continuously adjusts the voltage drop across the series passing tube so as to keep the sample voltage equal to the voltage of the reference tube. Any difference in voltage, the error, is amplified by V104 and V105 and thus changes the voltage drop across V101 to maintain the output at 500 volts.

c. For proper operation a highly stable and accurate balance of amplification must be maintained between the two halves of differential amplifier V104. The filament supply for V104 must be regulated to maintain this balance. Regulation is provided by a transistor regulator which supplies constant voltage to the filament of V104. The filaments of the AC to DC converter tubes (V501 and V502) are also supplied by this regulator. A filtered full wave rectifier (CR104, CR105, and C103) which is regulated by a three transistor network (Q1, Q2, and Q3) supplies the regulated DC filament voltage. One side of the filaments are connected to the reference supply common (0 volts) while the other side is maintained at approximately 5.9 volts through the emitter-collector junction of Q3. The output of Q1 drives a Darlington connection of Q2 and Q3. Any variation in the unregulated supply causes a corresponding change in the voltage across the emitter-collector junction of Q3 so that the filament voltage of V104, V501, and V502 remains stable.

d. RANGE DIVIDER. In the 500 volt DC range the output of the 500 volt supply is passed directly to the Kelvin-Varley attenuator by range section S2F. In the 50, 5, and 0.5 volt DC positions, range resistors (R320 through R330) selected by section S2E divide the reference voltage to 50, 5, and 0.5 volts before it is switched to the Kelvin-Varley attenuator by section S2F. With the AC - DC switch set to AC, AC - DC switch section S5G (S5E for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326) provides connection to the range resistors that divide the reference to 5 volts. This 5 volts is then passed to the Kelvin-Varley attenuator by section S5F (S5D for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823 AR/AG serial numbers 123 to 326). The voltage applied to the Kelvin-Varley attenuator is always 5 volts for AC because the AC to DC converter always supplies up to a maximum of 5 volts to the vtvm attenuator.

e. KELVIN-VARLEY ATTENUATOR. The five Kelvin-Varley decade resistor strings R401 through R455 and associated voltage dials A through E (S6 through S10) provide a means of making the four precision voltages (500, 50, 5, and 0.5) adjustable. Note that each string, with the exception of the first, parallels two resistors of the preceding string. Between the two wipers of S6 (voltage dial A) then, there is a total resistance of 40K (80K paralleled by 80K). With the range switch in the 500 volt position, a total voltage of 100 volts DC will appear across these two wipers. Also, there will be 10, 1, and 0.1 volts DC across the wipers of S7, S8, and S9, respectively. Voltage dial E (S10) picks increments of 0.01 volt DC from the last decade. These voltages are reduced by a factor of 10 for each lower voltage range. The Kelvin-Varley resistors are matched for both temperature coefficient and tolerance thus providing an overall attenuator accuracy of 0.002% absolute. With the null switch in any null range, the output of the Kelvin-Varley attenuator is connected in series with the vtvm attenuator thus providing the accurate 0 to 500 volts reference required.

f. ADJUSTMENTS. Variable resistor R121 is used during calibration to set the 500 volt supply to 500 volts with calibrate control R12 set at its center of rotation. This allows the reference supply to be adjusted to 500 volts by means of the calibrate control at any time deemed necessary. With the operate-calibrate switch held at calibrate, a fixed percentage of the 500 volt supply is compared to the precise potential of an internal standard cell or Zener diode (in the /AG models). Any difference in potential is fed to the null detector to give an indication on the meter so that the 500 volt supply can be set with the calibrate control. The fixed percentage of the reference supply is set accurately during calibration by means of R318. The 50, 5, and 0.5 volt range resistor networks are set accurately during calibration by means of R323, R326, and R329.

3-4. AC TO DC CONVERTER

a. GENERAL. The AC to DC converter is composed of an attenuator, an operational amplifier, and a rectifier-filter circuit. A diode in the rectifier-filter circuit is used to convert the unknown AC into pulsating DC, which is then filtered to obtain a DC voltage that is proportional to the average value of the AC input voltage. The output however, is calibrated to indicate the rms value of a pure sine wave. An operational amplifier containing three resistance-capacitance coupled amplifier stages with high negative feedback is used to make the rectification characteristics of the diodes linear and stable. The amplifier achieves a midband loop gain of approximately 70 db with a virtually flat frequency response from 20 cps to 10 kc. The high negative feedback makes the amplifier practically noise free and relatively insensitive to gain changes in individual tubes due to aging and tube replacement. At the output to the amplifier, full wave rectification is used to return negative feedback to the grid of the first amplifier tube. The attenuator is used to reduce the AC input voltage by a factor of 10 or 100, as required to restrict the operational amplifier input to 5 volts maximum for full scale inputs of 50 and 500 volts respectively.

b. OPERATION. All AC measurements are made by first converting the AC input voltage to a DC voltage. The converter provides a DC output of 5 volts when full range voltage is applied to the 823A in each AC range. In the 5 volt AC position, range switch sections S2G and S2H connect the input binding posts directly to the converter input. In this case, the converter feedback is of such a value that the DC output voltage is equal to the rms value of the converter input AC voltage. In the 500 and 50 volt AC positions, an input attenuator reduces the unknown AC by a factor of 100 and 10 respectively. The

operation of the converter is then the same as for the 5 volt position. In the 0.5 volt AC position, range switch section S2I and section S2J provide connection to feedback resistors that allow the converter to produce an output that is equal to ten times the AC input. Thus, an output of 5 volts DC is provided for full scale input on any AC range.

c. NULL INDICATIONS. When making AC differential measurements, the null range used times the applicable AC null multiplier must be used to represent full scale on the 823A meter. This is due to the way that the converter is constructed. For the 500 volt AC range, the converter produces a DC output voltage equal to 1/100 of the AC input voltage. Thus, the AC null multiplier for the 500 volt range position is X100. For example, when the range switch is set to 500 and the null switch is set to 0.01, full scale meter deflection represents a one volt (100 x 0.01) difference between the unknown voltage and the amount set on the voltage readout dials. By similar reasoning, the multipliers for the 50, 5, and 0.5 volt AC ranges are X10, X1, and X0.1, respectively.

d. ADJUSTMENTS. For 0.5 volt converter gain, R536 and R545 at the output of the converter are adjusted. The gain of the amplifier for the 5 volt range is adjusted by means of R542 and R541 in the feedback network. The high frequency response of the amplifier input is adjusted by means of C504 while C519 adjusts the high frequency response of the 0.5 volt feedback circuit. The attenuation of the 500 volt attenuator is adjusted with R535 and R544 and the attenuator high frequency response is adjusted with C501. The attenuation of the 50 volt attenuator is adjusted with R503 and R533 and the attenuator high frequency response is adjusted with C523.

3-5. AC - DC POLARITY SWITCH

a. The AC - DC polarity switch is provided for selecting either the AC or DC mode of operation. When the AC - DC polarity switch is set to AC, the AC to DC converter is switched into the circuit by sections S5K, S5L, S5M, and S5N. Also, sections S5F and S5G (S5D and S5E for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326) are used to switch 5 volts DC to the Kelvin-Varley divider. When in the AC vtvm mode, S5H (S5F for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326) is used to provide proper attenuation for the DC attenuator.

b. The AC - DC polarity switch may be set to either of two positions, positive or negative, for the DC mode of operation. As seen in figure 3-2, the AC - DC polarity switch does not reverse the input posts when going from the positive to negative DC position. It reverses the meter and the internal reference supply. If the instrument did not contain positive and negative DC positions, the grounded side of any unknown voltage that is negative with respect to ground would have to be connected to the upper input binding post. This would ground the upper post and effectively place C1 (a 0.47 uf capacitor) across the input terminals. Even if C1 was disconnected, there would still be considerable capacitance across the input due to transformer winding capacitance and stray wiring capacitance. With this capacitance across the circuit being measured several problems could arise. The polarity switch provides equal convenience in measuring positive or negative voltages without the occurrence of these problems.

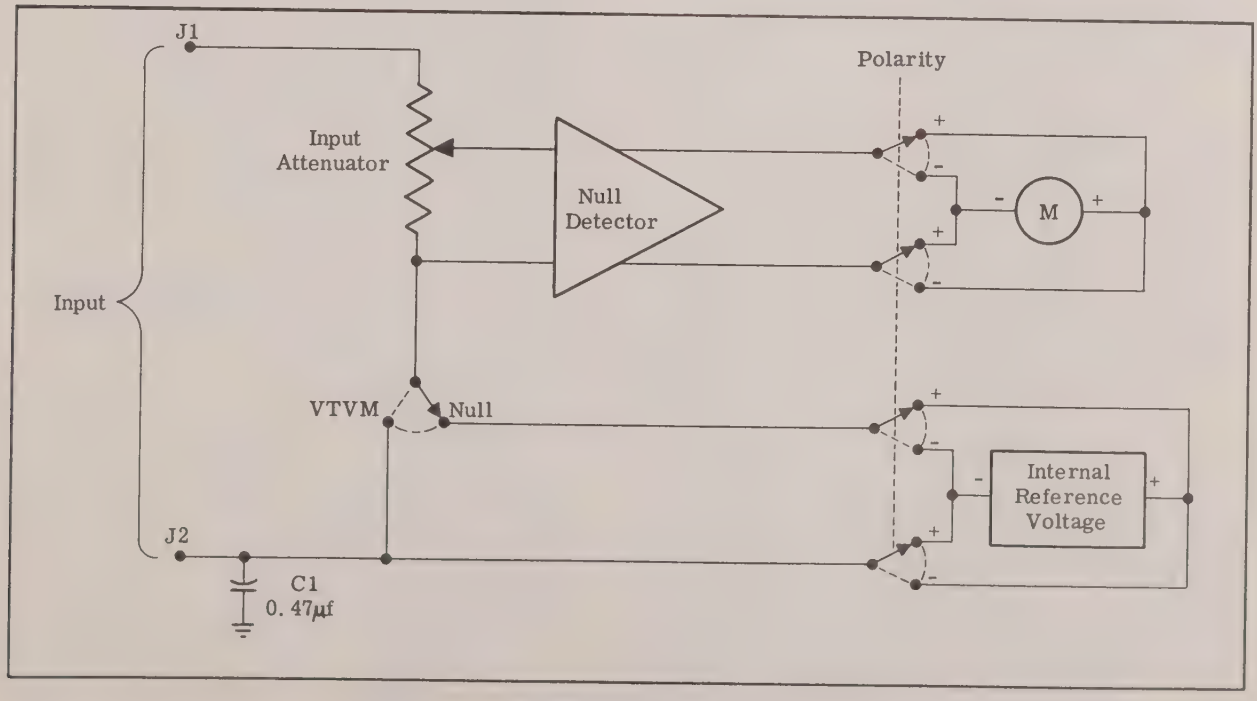


Figure 3-2. FUNCTION OF POLARITY SWITCH

SECTION IV

MAINTENANCE

4-1. GENERAL

The 823A AC/DC Differential Voltmeter seldom requires any maintenance. Without extreme abuse, all that should be required is occasional cleaning, tube replacement and calibration. Periodic maintenance consists only of preventing any leakage as discussed in paragraph 4-2. A discussion of troubleshooting along with a troubleshooting chart, component location diagrams, and a tube voltage chart are provided in paragraph 4-3. Paragraph 4-4 delineates the equipment and procedures necessary to calibrate the instrument.

4-2. PERIODIC MAINTENANCE

a. LEAKAGE PREVENTION. The accuracy of the 823A is adversely affected by excessive electrical leakage from the input of the null detector to either ground or the 500 volt reference supply. Special care has been taken to prevent leakage across certain critical switch wafers and areas of some printed circuit boards due to moisture from condensation. The printed circuit boards have been coated with Humi-Seal 1B12. The range, null, operate-calibrate, and polarity switches have been dipped in Dow Corning silicone oil. Accumulations of dust and foreign matter will cause internal leakage, and should be removed as often as necessary, depending on environmental operating conditions.

b. To check for excessive electrical leakage, proceed as follows:

(1) Perform preliminary operation procedure as stated in paragraph 2-3.

(2) Set switches on 823A as follows:

RANGE	500
NULL	0.1
voltage readout dials	490.00

(3) Remove test leads from input posts.

(4) Excessive leakage is indicated if the meter deflects more than one-tenth of full scale.

c. To prevent excessive electrical leakage, proceed as follows:

(1) Blow the instrument out with low-pressure, clean, dry air to remove most accumulations of dust and foreign matter. Pay particular attention to the binding posts, binding post wiring, critical switches (NULL, RANGE, OPERATE-CALIBRATE, and polarity switches), and for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326 the two glass epoxy strips which insulate the null detector chassis from the main chassis.

(2) Clean the glass epoxy strips, binding posts, insulators, and front panel with a rag saturated in anhydrous denatured ethyl alcohol.

(3) When necessary, wash all exposed dielectric surfaces of the NULL, RANGE, OPERATE-CALIBRATE, and polarity switches with denatured alcohol using a small, stiff-bristled brush.

CAUTION

Do not use Metriclene, acetone, lacquer thinner, or any other methyl ethyl ketones, since they will react with the Lexan rotor on the CTS plastic switches.

(4) After washing, recoat the exposed switch insulating material with a solution of Dow Corning 200 having a viscosity between 5 and 20 centistokes. This prevents leakage due to moisture on these surfaces.

d. STANDARD CELL REPLACEMENT. As a standard cell ages, its temperature-voltage hysteresis increases. This means that the standard cell voltage takes a longer time to return to its equilibrium value following a temperature change. To be confident of the 0.01% accuracy inherent in the 823A and 823AR, the standard cell should be replaced approximately every four years when the instrument is subjected to temperature changes before measurements are made. However, if the 823A or 823AR is used to make measurements at similar temperatures, the usefull life of the standard cell should far exceed four years.

4-3. CORRECTIVE MAINTENANCE

a. TROUBLESHOOTING. The purpose of troubleshooting is to quickly and accurately determine the cause of any abnormal condition. To assist in localizing most troubles which might occur, the causes and remedies for a number of symptoms are listed in the troubleshooting chart (figure 4-1). Since failure of the 823A is usually due to tube failure, it is recommended that tube substitution be tried before any other tests are made. However, the 823A is conservatively designed and should

SYMPTOM	PROBABLE CAUSE	REMEDY
Drift of the 500 volt DC reference supply evidenced by the continual need for resetting with the CALIBRATE control.	V102, V104, or V105 defective.	Check V102, V104, and V105 by replacement.
	One of the sampling string resistors (R123, R124, R121) is changing value rapidly as the instrument warms up.	Locate faulty resistor by heating slightly with a soldering iron held near the resistor while observing the 500 volt DC calibration.
	Drifting standard cell emf possibly caused by previous shorting or inverting of the cell.	Allow time for the standard cell to stabilize. Several hours should be sufficient.
Cannot calibrate 500 volt DC reference supply.	Excessive aging of V102.	Check V102 by replacement.
Meter cannot be brought to zero with CALIBRATE control.	Out of calibration.	Recalibrate per paragraph 4-4b.
	One or more resistors in 500 volt DC sampling string has shifted in value.	Recalibrate per paragraph 4-4b and observe stability for 48 hours. If 500 volt DC reference supply remains stable, replacement of resistor is unnecessary.
	Standard cell emf has shifted.	Recalibrate instrument and observe stability of reference supply. Replacement of the standard cell may be necessary.
Measurements are out of tolerance on one range other than the 500 volt range.	A reference supply output range resistor on the range resistor printed circuit board is out of tolerance.	If the trouble occurs in the 50 volt range, R324 has shifted; in the 5 volt range, R327 has shifted: in the 0.5 volt range, R330 has shifted. It may be possible to correct by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on all ranges other than the 500 volt range.	R320, R321, or R328 has shifted in value.	It may be possible to correct all range voltages by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on any range when the Kelvin-Varley divider is dialed to any setting other than 499910.	One of the Kelvin-Varley divider resistors is out of tolerance.	Check Kelvin-Varley accuracy per paragraph 4-3e.
Instrument is out of specifications on all null ranges.	Resistors R6, R7, R8, R9, R10, or R11 out of tolerance.	Check and replace faulty resistor.

Figure 4-1. TROUBLESHOOTING (sheet 1 of 2)

SYMPTOM	PROBABLE CAUSE	REMEDY
Meter rattle, drift, or error is observed on all null ranges.	V202, V203, or V204 faulty. Chopper G1 faulty. (823A & 823A/AG 123 to 502 823AR & 823AR/AG 123 to 326) Moisture or dirt on printed circuit boards or switches.	Check V202, V203, and V204 by replacement. Replace chopper. Clean instrument.
NOTE: Assuming all DC measurements are normal, the following symptoms are common to AC measurements only.		
Measurements are out of tolerance on 500 volt AC range only.	Out of calibration. One or more resistors in 500 volt AC attenuator has shifted in value.	Recalibrate per paragraph 4-4c. Recalibrate per paragraph 4-4c. Recheck calibration after 48 hours and if attenuator has remained stable, replacement of resistor is unnecessary. If attenuator does not remain stable, or calibration is not possible, replace faulty resistor.
Measurements are out of tolerance on 50 volt AC range only.	Out of calibration. One or more resistors in 50 volt AC attenuator has shifted in value.	Recalibrate per paragraph 4-4c. Recalibrate per paragraph 4-4c. Recheck after 48 hours and if attenuator has remained stable, replacement of resistor is unnecessary. If attenuator does not remain stable or if calibration is not possible, replace faulty resistor.
Measurements out of tolerance on all AC ranges.	Out of calibration. V501 or V502 faulty.	Recalibrate per paragraph 4-4c. Check V501 and V502 by replacement.
Measurements out of tolerance at a specific frequency.	Out of calibration. Faulty frequency compensation capacitor.	Recalibrate per paragraph 4-4c. Locate faulty capacitor and replace. If trouble occurs on all ranges, check C504. If trouble occurs on 500 volt range only, check C501, C502, and C521. If trouble occurs on 50 volt range only, check C523 and C524. If trouble occurs on 500, 50, and 5 volt range, check C520. If trouble occurs on 0.5 volt range check C519.

Figure 4-1. TROUBLESHOOTING (sheet 2 of 2)

require very infrequent tube replacement. At certain times, a check of the operating level voltages of the tubes (figure 4-2) and transistors (figure 4-3) is also useful. As an aid to troubleshooting, all components may be located by referring to the figures shown in Section V. An understanding of the theory of operation (Section III) and frequent reference to the schematic diagram will be of great value in troubleshooting.

WARNING

Use extreme care when working inside the instrument while it is on. The null detector assembly and all components thereon will be at a voltage close to that indicated by the voltage readout dials.

b. TUBE REPLACEMENT. Many differential amplifier circuits are critical with respect to the balance between halves of differential amplifier tubes. This is especially true of the first stage of amplification. However, the 823A is designed with the ability to use any 12AX7 for V104 and V105 that meets standard EIA (Electronics Industries Association) characteristics. Some output voltage drift of the 500 volt reference supply may be noted for the first few hours of operation. This drift will, in most cases, decrease to a small value after the tube has aged a bit. Occasionally a tube with a contaminated grid or extremely poor balance between halves will be found. This tube should be discarded. When replacing reference tube V102, the new tube should be aged at least 150 hours to realize the high order of stability inherent in the 823A. A tube that has been aged may be obtained by ordering an 0G3-2 from Fluke.

Symbol & Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V101, 6BQ5	No Conn.	495	500 (±3%)	Heater voltage 6.3 volts ac		No Conn.	680 to 730	No Conn.	680 to 730
V102, OG3	85 (±3%)	0	Int. Conn.	0	85 (±3%)	Int. Conn.	0	No Pin	No Pin
V104, 12AX7	217	84	86	Heater voltage 5.9 volts dc		217	84	86	See Pin 4 & 5
V105, 12AX7	495	217	220	Heater voltage 6.3 volts ac		500	217	220	
V202, 5751 (823A, 823A/AG 123 to 502 823AR, 823AR/AG 123 to 326)	60	-	0	Heater voltage 12 volts dc		100	-	1.5	No Conn.
V203, 6AW8 (823A, 823A/AG 123 to 502 823AR, 823AR/AG 123 to 326)	47	45	140	Heater voltage 6.3 volts ac		0.7	-	25	50
V204, OA2 (823A, 823A/AG 123 to 502 823AR, 823AR/AG 123 to 326)	150	0	Int Conn.	0	150	Int. Conn.	0	No Pin	No Pin
V501, 6EJ7	1.3	-	1.3	Heater voltage 5.9 volts dc		0	150	93	1.3
V502, 6AW8	28	-	200			1.8	-	100	150 (±50%)

This chart is to be used under the following conditions: (a) RANGE switch set to 500; (b) NULL switch set to VTVM: (c) all voltage readout dials set to zero; (d) polarity switch set to +; (e) line voltage at 115/230 volts, 50 - 440 cycles; (f) all measurements made with vtvm from negative binding post to specified terminal; and (g) all voltages may vary by 20% unless otherwise indicated.

Figure 4-2. TUBE VOLTAGE CHART

TRANSISTOR	Q1	Q2	Q3	Q201	Q202	Q203	Q204	Q205	Q206	Q207
E	3.0	9.3	9.7	-0.45	-0.45	-0.45	0	0.58	-0.54	17.2
B	3.5	9.2	9.3	0	0	0	0.5i	0.98	0	16.5
C	9.2	5.8	5.8	0	0	9.2	0.98	7.5	16.5	0

This chart is to be used under the following conditions: (a) voltages for transistors Q201 to Q207 apply to 823A & 823A AG serial numbers 503 and on and 823AR & 823AR AG serial numbers 327 and on only; (b) RANGE switch set to 500; (c) NULL switch set to VTVM; (d) all voltage readout dials set to zero; (e) polarity switch set to +; (f) line voltage at 115 230 volts, 50-440 cycles; (g) all measurements made with vtvm from negative binding post to specified terminal; and (h) all voltages may vary by 20% unless otherwise indicated.

Figure 4-3. TRANSISTOR VOLTAGE CHART

c. Replacement of tubes will not normally necessitate complete recalibration of the 823A. If V202 or V203 is replaced for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326, calibrate the null detector as set forth in paragraphs 4-4b (1) and 4-4b (2). Replacement of V101, V102, V104, or V105 will necessitate calibration of the reference supply per paragraphs 4-4b (1) and 4-4b (3). If V501 or V502 is replaced, calibrate the AC to DC converter as in paragraph 4-4c.

d. COMPONENT REPLACEMENT. Should it ever become necessary to replace a component on a printed circuit board (or on the null detector chassis for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823 AR/AG serial numbers 123 to 326), proceed as follows:

(1) Clean soldered area around component with methyl ethyl ketone.

(2) Remove part and install new component.

(3) Remove flux with du Pont Freon PC.

(4) Allow to dry for 10 minutes. When it is cool or humid, it may be necessary to place area under a lamp to ensure thorough drying.

(5) For 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326, coat any uncoated areas around the input to the null detector chassis (tube V202, 5751, and chopper) with Humi-Seal 1B12 (manufactured by Columbia Technical Corp. of Woodside, N. Y.).

e. KELVIN-VARLEY ACCURACY CHECKING. For this procedure, it is recommended that a six dial Kelvin-Varley divider with a linearity of one part per million and an input capability of 500 volts, a lead compensator, a Fluke Model 301C or 301E Power Supply, and a Fluke Model 825A DC Differential Voltmeter or equivalent be used. To check the accuracy of the Kelvin-Varley divider, proceed as follows:

(1) Disconnect 823A from line power.

(2) On cabinet models, remove screws at back of cabinet and slide instrument out of case.

(3) Remove four screws that hold front panel assembly to chassis and proceed to step (5).

(4) On rack models, remove six screws that hold front panel assembly to chassis.

(5) Being careful to avoid wiring damage, gently lift front panel assembly from instrument and set face down in front of instrument.

(6) Locate high input (wire connected from range switch to S6, usually white-red), high output (wire connected from polarity switch to S10, usually yellow), and input-output common (wire connected from tie point to S6, usually black) of Kelvin-Varley divider.

(7) Connect equipment as shown in Figure 4-4.

(8) Set 823A RANGE switch to 500.

(9) Turn on all equipment and allow it to warmup to equilibrium temperature.

(10) Set power supply for an output of 500 volts DC.

(11) Set 823A voltage readout dials to 00000 and standard divider to 000000.

(12) Set switches on 825A as follows:

RANGE	500
NULL	.001
voltage readout dials	00000
POWER	ON

(13) Adjust lower lead compensator for a null on 825A.

(14) Set 823A voltage readout dials to 499910 and standard divider to 9999910.

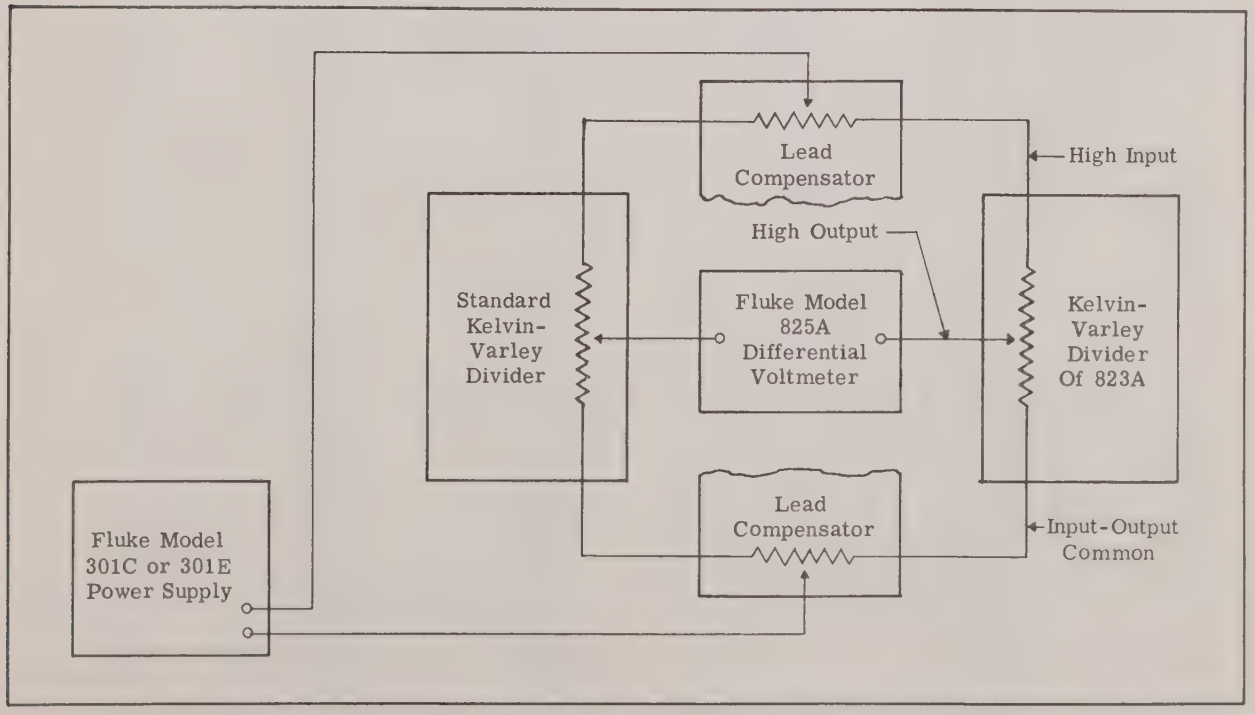


Figure 4-4. KELVIN-VARLEY DIVIDER CHECKING SETUP

(15) Adjust upper lead compensator for a null on 825A.
(16) Set 825A NULL switch to .01 and change to .001 when more sensitivity is required to take a reading.
(17) Set 823A voltage readout dials and standard divider to positions shown in Figure 4-5. The 825A null detector indication should be equal to or less than the listed deviation. If Kelvin-Varley divider is out of tolerance between settings of 499910 and 099910, recalibrate as set forth in paragraph 4-4d and then recheck. If a resistor-trimmer combination of the first deck can not be adjusted for a null during calibration, the 39,996 ohm resistor is defective and must be replaced. If Kelvin-Varley divider is out of tolerance for remaining settings, replace defective resistor. All resistors of each decade are matched and the decades are matched for each instrument. When ordering a Kelvin-Varley resistor, the instrument model and serial number as marked on the name plate and all the information stamped on the resistor must be supplied to Fluke. This ensures that a resistor compatible with the matched resistor group within the instrument is used. The Kelvin-Varley resistors are very stable and precise, resistance is clearly defined, therefore; they must be handled with care. This is especially true of the varnished-dipped-card resistors.

CAUTION

Pick up card resistors between ends of card. Never touch the wire on the cards as damage to the resistor could possibly result.

If it becomes necessary to replace a resistor in the first deck (R401 to R406 or R450 to R455), recalibrate the Kelvin-Varley divider as set forth in paragraph 4-4d.

f. STANDARD CELL PROBLEMS. The standard cell of the 823A deserves special consideration if it is suspected of being faulty:
(1) The standard cell used is a miniature unsaturated cell which has excellent long term stability and negligible, temperature-voltage hysteresis. (Temperature-voltage hysteresis is the erratic behavior of the voltage while the cell is coming to equilibrium following a change in temperature.) With time, however, the temperature-

823A Voltage Dial Settings	Standard Divider Settings	Maximum Deviation (± millivolts)	823A Voltage Dial Settings	Standard Divider Settings	Maximum Deviation (± millivolts)
499910	.9999910	0			
40000	.800000	8.0	006910	.014000	.6
399910	.800000	8.0	00600	.012000	
30000	.600000	6.0	005910	.012000	
299910	.600000	6.0	00500	.010000	
20000	.400000	4.0	004910	.010000	
199910	.400000	4.0	00400	.008000	
10000	.200000	2.0	003910	.008000	
099910	.200000	2.0	00300	.006000	
09000	.180000	1.8	002910	.006000	.6
089910	.180000	1.8	00200	.004000	.4
08000	.160000	1.6	001910	.004000	
079910	.160000	1.6	00100	.002000	
07000	.140000	1.4	000910	.002000	
069910	.140000	1.4	00081̄0	.001800	
06000	.120000	1.2	00071̄0	.001600	
059910	.120000	1.2	00061̄0	.001400	
05000	.100000	1.0	00051̄0	.001200	
049910	.100000	1.0	00041̄0	.001000	
04000	.080000	1.0	00031̄0	.000800	.4
039910	.080000	1.0	00021̄0	.000600	.3
03000	.060000	.8	00011̄0	.000400	
029910	.060000	.8	00001̄0	.000200	
02000	.040000	.8	00009	.000180	
019910	.040000	.8	00008	.000160	
01000	.020000	.6	00007	.000140	
009910	.020000	.6	00006	.000120	
00900	.018000	.6	00005	.000100	
008910	.018000	.6	00004	.000080	
00800	.016000	.6	00003	.000060	
007910	.016000	.6	00002	.000040	
00700	.014000	.6	00001	.000020	.3
			00000	.000000	.0

Figure 4-5. KELVIN-VARLEY ERROR LIMITS

voltage hysteresis increases. The 823A uses the latest type of cells which have a useful life that should exceed 5 years under normal operating conditions, storage and operating temperatures between 68°F and 86°F.

(2) Failure of the standard cell may occure if subjected to below freezing temperature. The electrolyte will start to freeze at about 5°F and operation below 32°F is definitely not recommended. If temperatures below -10°F are encountered for more than 4 hours, it is recommended that the standard cell be replaced. The life of the cell will also be shorter if the cell is operated at elevated temperatures. For approximately every 22°F rise in temperature above 73°F, the aging rate is doubled. For example, the cell will typically decrease in voltage by 20 ppm/yr at 73°F, 40 ppm/yr at 95°F, and 80 ppm/yr at 117°F.

(3) The emf of different cells may vary as much as 0.05% and each instrument is calibrated to its own particular standard cell. Thus, when the standard cell is replaced, the 821A reference supply must be recalibrated as in paragraph 4-4b (3).

(4) The emf of the standard cell will change if the cell has been inadvertently short circuited. If the emf of the cell has changed, the 823A will naturally be out of calibration on all ranges. However, if the cell has been shorted for only a few seconds, the cell will recover enough within 10 minutes to make measurements within specifications. Also, if the cell has been inverted for a few days, the voltage will recover enough to make measurements within specifications immediately upon being restored to an upright position.

g. DECIMAL LAMP REPLACEMENT. The decimal lamps are normal 6.3 volt lamps. To prolong their life these lamps are operated from a 5 volt transformer winding. However, these lamps do occasionally fail. To replace, proceed as follows:

(1) On cabinet models, remove screws at back of cabinet and slide instrument out of case. If only the upper most decimal lamp needs to be replaced, proceed to step (6).

(2) Remove four screws that hold front panel assembly to chassis.

(3) Being careful to avoid wiring damage, gently lift front panel assembly from instrument and set face down in front of instrument.

(4) Remove screws holding range resistor board to front panel assembly.

(5) Push printed circuit board aside enough to allow access to light holders.

(6) Remove light holder from bracket by applying pressure to each side of holder.

(7) Remove cardboard light shield and replace lamp.

(8) On rack models, remove screws holding cover to instrument and set cover aside.

(9) Remove light holder from bracket by applying pressure to each side of holder.

(10) Remove cardboard light shield and replace lamp.

h. CHOPPER DRIVE FREQUENCY ADJUSTMENT FOR 823A & 823A/AG SERIAL NUMBERS 123 TO 502 AND 823AR & 823AR/AG SERIAL NUMBERS 123 TO 326. If it ever becomes necessary to replace one or more of the chopper drive unit transistors (Q701 through Q704), the frequency and symmetry of the output must be reset. Proceed as follows:

(1) After replacing transistors, connect an oscilloscope between the emitter of Q703 and lower input post (middle post) to observe the output waveform.

(2) Adjust R704 until output is within ±3% of symmetry.

(3) Adjust R705 for a frequency of 83 cycles ±2%.

i. CHOPPER DRIVE FREQUENCY ADJUSTMENT FOR 823A & 823A/AG SERIAL NUMBERS 503 & ON AND 823AR & 823AR/AG SERIAL NUMBERS 327 & ON. The chopper drive frequency needs to be adjusted only a few times during the life of the instrument. As neon lamps DS202 and DS203 age, their voltage will change slightly and cause the frequency to shift. This is especially true during the early life of the instrument. However, the chopper drive frequency needs to be adjusted only if a beating effect appears on the meter due to line frequency interference. Proceed as follows:

(1) Set controls on voltmeter as follows:

POLARITY	+ (positive)
NULL	.001
all voltage readout dials	0 (zero)

(2) Connect an oscillator to input of voltmeter through a capacitor of about 0.1 microfarads.

(3) Set oscillator for an output of 84 cycles.

(4) Adjust R226 until meter begins to beat and then adjust for zero beat.

4-4. CALIBRATION

a. GENERAL. The calibration procedure is divided into two main parts: DC Differential Voltmeter Calibration (paragraph 4-4b) and AC to DC Converter Calibration (paragraph 4-4c). The 823A may be calibrated as often as deemed necessary. However, it is recommended that DC differential voltmeter calibration be done every 6 months. The AC to DC converter calibration should be done every month. For special applications where extreme accuracy is required, it may be desired to calibrate the instrument more often. If subjected to a temperature greater than 130°F or less than 10°F, the instrument should be recalibrated; but, it should be recalibrated no sooner than 24 hours after being removed from the extreme temperature environment. If the instrument is subjected to a temperature of less than -10°F for more than 4 hours, it is recommended that the standard cell be replaced. Calibration should be accomplished in a draft-free area with an ambient temperature of 72(±3)°F for maximum accuracy under laboratory conditions. The recommended equipment and the specifications required for calibration are shown in figure 4-6. All controls on the cabinet model may be located with the aid of figure 4-7. The instrument must be calibrated in its cabinet. The ventilation holes on the cabinet model provide an easy means of reaching R121, R205 (or R222), and R212 (or R232). An insulated screwdriver must be used when adjusting these controls to prevent shorting the control to chassis ground. To reach the calibration controls at the front of cabinet models, the instrument must be slid partly out of its cabinet. On rack models, all controls may be easily reached through labelled access holes.

b. DC DIFFERENTIAL VOLTMETER CALIBRATION. For convenience, the DC differential voltmeter calibra-

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED
DC CALIBRATION: Fluke 301C or 301E Power Supply Saturated standard cell bank with an accuracy of ±0.001% Voltage reference divider having division ratios of 1, 10, 100, and 1000 with an accuracy of ±0.001% Galvanometer suitable for use with above voltage reference divider	The equipment used must provide 500, 50, 5, and 0.5 volts with accuracy of 0.002%.
AC CALIBRATION: Fluke Model 821A Differential Voltmeter Fluke 301C or 301E Power Supply Krohm-Hite LDS-1500 Oscillator Fluke 540A Transfer Standard	The equipment used must provide 500, 50, 5, and 0.5 volts AC at 400 cycles, 10 kilocycles, and 20 kilocycles with an accuracy of at least 0.03% and with less than 0.1% total harmonic distortion.

Figure 4-6. CALIBRATION EQUIPMENT

tion is divided into four parts: Preliminary Calibration, Null Detector Calibration, Reference Supply Calibration, and Range Divider Calibration. Normally, all four parts are performed in the sequence given here. However, the calibration procedure is written so that any part may be calibrated by performing the procedure for just that part.

(1) Preliminary Calibration Procedure.

(a) Set 823A meter to zero with mechanical adjustment screw on front of meter case.

(b) Set switches on 823A as follows:

RANGE	500
NULL	VTVM
AC - DC polarity	+ (positive)
all voltage readout dials	0 (zero)

(c) Set power switch to ON and allow 823A to warm to equilibrium temperature (about 1 hour) inside its case. Meanwhile, proceed with step (d).

(d) Set up necessary equipment to provide DC voltages of 500, 50, 5, and 0.5 volts DC with an accuracy of 0.002%. Proceed as follows: turn on all test equipment and allow it to warm to equilibrium temperature (about 1/2 hour); set proper standard cell voltage on divider; apply 500 volts DC into divider from power supply; set divider to 500 and zero galvanometer by varying output of power supply; voltages of 500, 50, 5, and 0.5 volts DC are made available at output posts by merely changing position of voltage selector switch on voltage divider.

(e) Connect chassis ground binding post to line ground.

(2) Null Detector Calibration.

(a) Perform preliminary calibration procedure as stated in paragraph 4-4b (1).

(b) Adjust null detector ZERO ADJ control R212 (R232 for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326) until meter indicates zero.

(c) Apply 500 volts DC (±0.002%) to voltmeter.

(d) Adjust VTVM GAIN ADJ control R205 (R222 for 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326) for full scale deflection.

(3) 500 VDC Reference Supply Calibration.

(a) Perform preliminary calibration procedure as stated in paragraph 4-4b (1).

(b) Center CALIBRATE control at its center of rotation.

(c) Set NULL switch to 10 and voltage readout dials to 499.910.

(d) Apply 500 volts DC (±0.002%) to voltmeter.

(e) Adjust 500V ADJ control R121 for a null.

(f) Set NULL switch to 0.1 volt.

(g) Null meter by adjusting CALIBRATE control.

(h) Advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE and null meter by adjusting REF CAL ADJ control R318.

(4) Range Divider Calibration.

(a) Perform preliminary calibration procedure as stated in paragraph 4-4b (1).

(b) Set switches on 823A as follows:

RANGE	50
NULL	0.01
voltage readout dials	49.9910

(c) Apply 50 volts DC (±0.002%) to voltmeter.

(d) Null 823A meter by adjusting 50V DC ADJ control R323.

(e) Set RANGE switch to 5 volts.

(f) Apply 5 volts DC (±0.002%) to voltmeter.

(g) Null 823A meter by adjusting 5V DC ADJ control R326.

(h) Set RANGE switch to 0.5 volts.

(i) Apply 0.5 volts DC (±0.002%) to voltmeter.

(j) Null 823A meter by adjusting 0.5V DC ADJ control R329.

This completes the DC differential voltmeter calibration.

c. AC TO DC CONVERTER CALIBRATION. The DC Differential Voltmeter section of the 823A must be within specifications before the AC to DC Converter can be accurately calibrated. The AC to DC Converter must be calibrated in the following order.

(1) Preliminary Calibration Procedure.

(a) Zero instrument as stated in paragraph 2-2.

(b) Check for excessive converter output noise as follows: set RANGE switch to 0.5, NULL switch to 0.01, AC - DC polarity switch to AC, all voltage readout dials to 0 (zero) and power switch to ON; short input terminals of 823A; if the meter needle is not within 150 microvolts (7-1/2 small divisions) of null, converter noise is excessive and the trouble must be corrected before proceeding with calibration; if trouble occurs it is usually the result of the input tube (V501), the filament

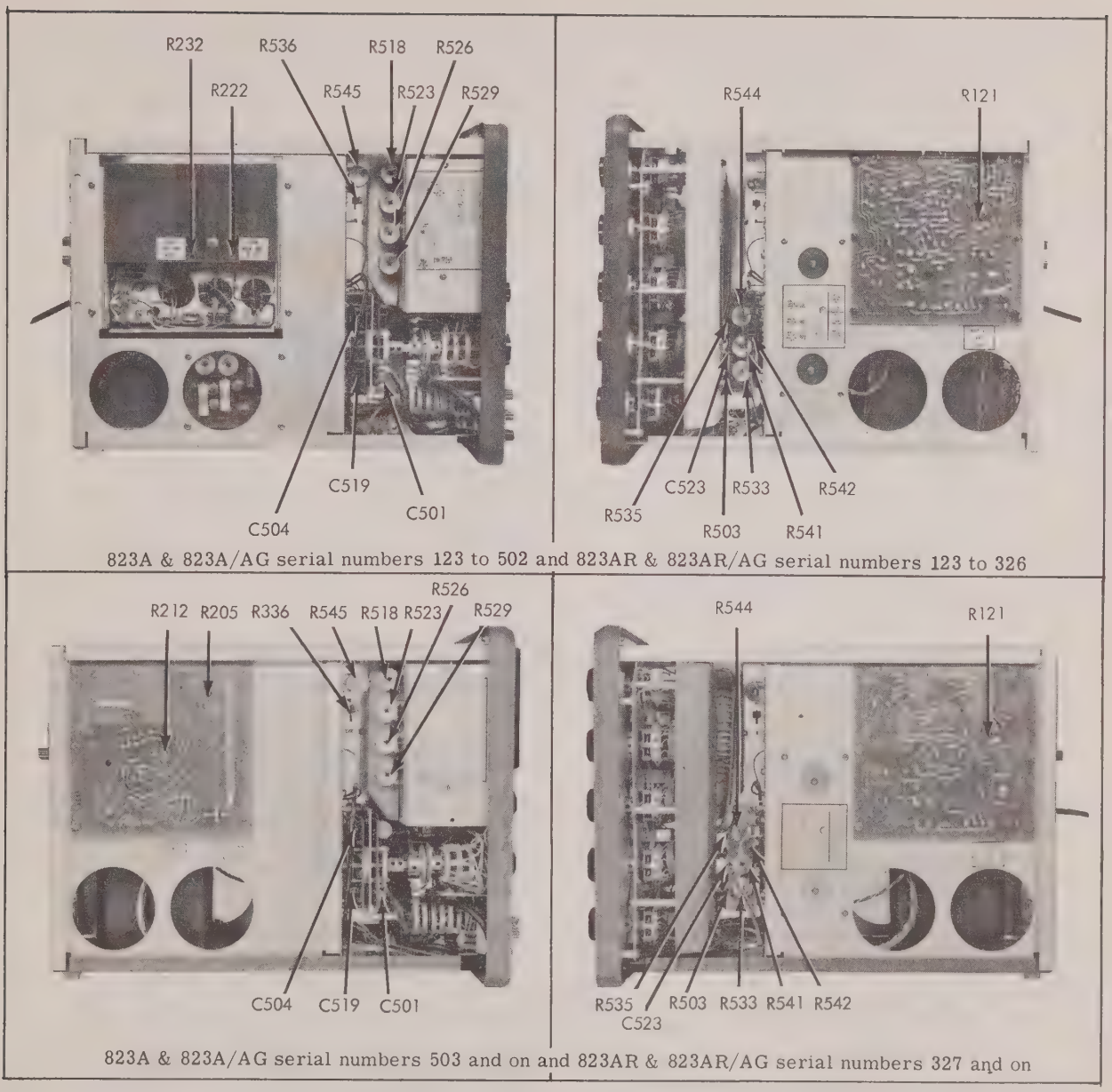


Figure 4-7. ADJUSTMENT LOCATIONS

supply, or the 500 volt supply being noisy. Remove short from input terminals.

(c) Set switches on 823A as follows:

RANGE	500
NULL	0.01
AC - DC polarity	AC
Voltage readout dials	499.910

(d) Allow 823A to warm to equilibrium temperature inside its case (about 1 hour). Meanwhile, proceed with step (e).

(e) Set up the necessary equipment to provide 500, 50, 5, and 0.5 volts AC with an accuracy of at least ±0.03% at frequencies of 400 cycles, 10 kilocycles, and 20 kilocycles with less than 0.1% total harmonic distortion. Proceed as follows: connect equipment as shown in figure 4-8; turn on all test equipment and allow it to warmup to equilibrium temperature (about 1/2 hour); adjust DC power supply voltage until differential voltmeter indicates rms value of AC voltage required; apply output of DC supply to 540A and null galvanometer by adjusting internal reference supply voltage; apply output of AC oscillator to 540A and null galvanometer by adjusting AC oscillator voltage; the output of the oscillator now equals the required voltage.

(2) 0.5 VAC Converter Gain Adjustment.

(a) Set RANGE switch to 0.5 volt position.

(b) Apply 0.5 volt AC at 400 cycles to voltmeter.

(c) Adjust 0.5 VAC GAIN COARSE ADJ control R536 and 0.5 VAC GAIN FINE ADJ control R545 until

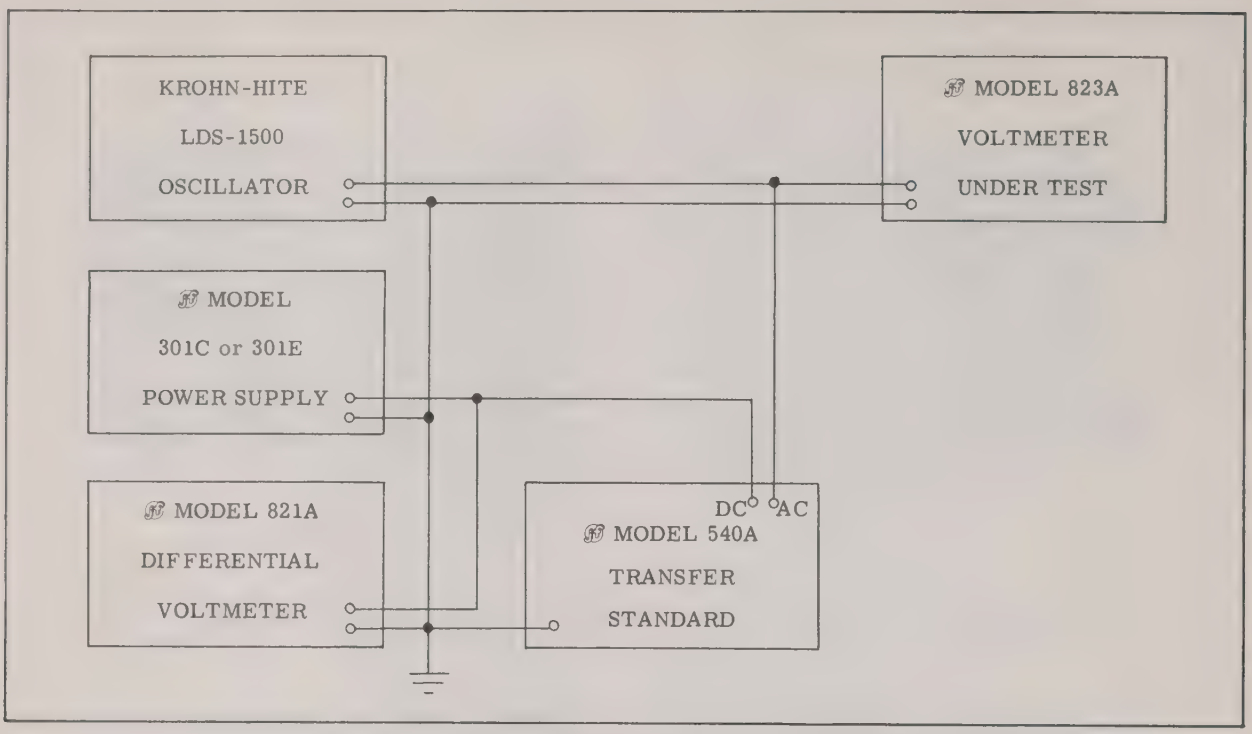


Figure 4-8. AC TO DC CONVERTER CALIBRATION SET-UP

meter needle is within ±30 microvolts (1-1/2 small divisions) of null. Use R545 for final touch up trying to keep control in center third of its mechanical range. Note position of meter needle.

(3) 5 VAC Converter Gain Adjustment.
(a) Set RANGE switch to 5 volt position.
(b) Apply 5 volts AC at 400 cycles to voltmeter.
(c) Adjust 5 VAC GAIN COARSE ADJ control R542 and 5 VAC GAIN FINE ADJ control R541 until meter needle is within ±300 microvolts (1-1/2 small divisions) of null. Use R541 for final touch up trying to keep control in center third of its mechanical range. Note position of meter needle.

(4) 5 VAC High Frequency Adjustment.
(a) Apply 5 volts AC at 10 kilocycles to voltmeter.
(b) Adjust 5 VAC HF TRIM control C504 until meter needle is within ±300 microvolts (1-1/2 small divisions) of needle position noted in (3).

(5) 0.5 VAC High Frequency Adjustment.
(a) Set Range switch to 0.5 volt position.
(b) Apply 0.5 volt AC at 20 kilocycles to voltmeter.
(c) Adjust 0.5 VAC HF TRIM control C519 until meter needle is within ±30 microvolts (1-1/2 small divisions) of needle position noted in (2).

(6) 0.5 VAC Converter Gain Check.
(a) Apply 0.5 volt AC at 400 cycles to voltmeter.
(b) If meter needle is not within ±50 microvolts (2-1/2 small divisions) of null, adjust 0.5 VAC GAIN FINE ADJ control R545 and then repeat (3), (4), and (5) before continuing with (7).

(7) 5 VAC Converter Gain Check.
(a) Set RANGE switch to 5 volt position.
(b) Apply 5 volts AC at 400 cycles to voltmeter.
(c) If meter needle is not within ±500 microvolts (2-1/2 small divisions) of null, adjust 5 VAC GAIN FINE ADJ control R541 and repeat (4) and (5) before continuing with (8).

(8) 500 VAC Attenuator Adjustment.
(a) Set RANGE switch to 500 volt position.
(b) Apply 500 volts AC at 400 cycles to voltmeter.
(c) Adjust 500 VAC ATTEN COARSE ADJ control R535 and 500 VAC ATTEN FINE ADJ control R544 until meter needle is within ±30 millivolts (1-1/2 small divisions) of null. Use R544 for final touch up trying to keep control in center third of its mechanical range. Note position of meter needle.

(9) 500 VAC High Frequency Adjustment.
(a) Apply 500 volts AC at 10 kilocycles to voltmeter.
(b) Adjust 500 VAC HF TRIM control C501 until meter needle is within ±30 millivolts (1-1/2 small divisions) of needle position noted in (8).

(10) 500 VAC Attenuator Check.
(a) Apply 500 volts AC at 400 cycles to voltmeter.
(b) If meter needle is not within ±50 millivolts (2-1/2 small divisions) of null, adjust 500 VAC ATTEN FINE ADJ control R544 and repeat (9) before continuing with (11).

(11) 50 VAC Attenuator Adjustment.
(a) Set RANGE switch to 50 volt position.
(b) Apply 50 volts AC at 400 cycles to voltmeter.

(c) Adjust 50 VAC ATTEN COARSE ADJ control R503 and 50 VAC ATTEN FINE ADJ control R533 until meter needle is within ±3 millivolts (1-1/2 small divisions) of null. Use R533 for final touch up trying to keep control in center third of its mechanical range. Note position of meter needle.

(12) 50 VAC High Frequency Adjustment.

(a) Apply 50 volts AC at 10 kilocycles to voltmeter.

(b) Adjust 50 VAC HF TRIM control C523 until meter needle is within ±3 millivolts (1-1/2 small divisions) of needle position noted in (11).

(13) 50 VAC Attenuator Check.

(a) Apply 50 volts AC at 400 cycles to voltmeter.

(b) If meter needle is not within ±5 millivolts (2-1/2 small divisions) of null, adjust 50 VAC ATTEN FINE ADJ control R533 and repeat (12).

This completes AC to DC converter calibration.

d. KELVIN-VARLEY CALIBRATION. The 823A Kelvin-Varley divider should be calibrated only after a resistor (R401 to R406 or R450 to R455) of the first deck has been replaced or after the Kelvin-Varley divider checking procedure (paragraph 4-3e) indicates that the Kelvin-Varley divider is out of tolerance. For this procedure, it is recommended that a six dial Kelvin-Varley divider with a linearity of one part per million, a Leeds and Northrup Model 9834 Galvanometer, and a Fluke Model 301C or 301E power supply be used. Proceed as follows:

(1) Disconnect 823A from line power.

(2) On cabinet models, remove screws at back of cabinet and slide instrument out of case.

(3) Remove four screws that hold front panel assembly to chassis and proceed to step (5).

(4) On rack models, remove six screws that hold front panel assembly to chassis.

(5) Being careful to avoid wiring damage, gently lift front panel assembly from instrument and set face down in front of instrument.

(6) Remove screws holding Kelvin-Varley board to front panel assembly and push board aside enough to allow access to Kelvin-Varley switches.

(7) Locate wires (usually white-black and white-brown) that connect second deck of Kelvin-Varley divider to first deck (wires are connected from S7 to S6 as shown in figure 5-2) and unsolder at S6.

(8) Connect equipment as shown in figure 4-9. The 80K resistance shown is total resistance of second through fifth deck which exists between wires unsoldered in step (7). The series connection of 39,996 ohm resistor and 10 ohm trimmer is one of six resistor-trimmer sets. Use each set, one at a time, by connecting at switch S6 to adjacent wires (usually blue) coming from Kelvin-Varley board.

(9) Turn all equipment on and allow it to warmup to equilibrium temperature (about 1/2 hour).

(10) Set power supply for an output of 100 volts DC.

(11) Set standard Kelvin-Varley divider to . 666667.

(12) Adjust 10 ohm trimmer resistor for a null on galvanometer.

(13) Repeat with next resistor-trimmer combination of the first deck until all six trimmer resistors (R450 to R455) have been adjusted.

(14) Check accuracy of Kelvin-Varley divider using procedure of paragraph 4-3e.

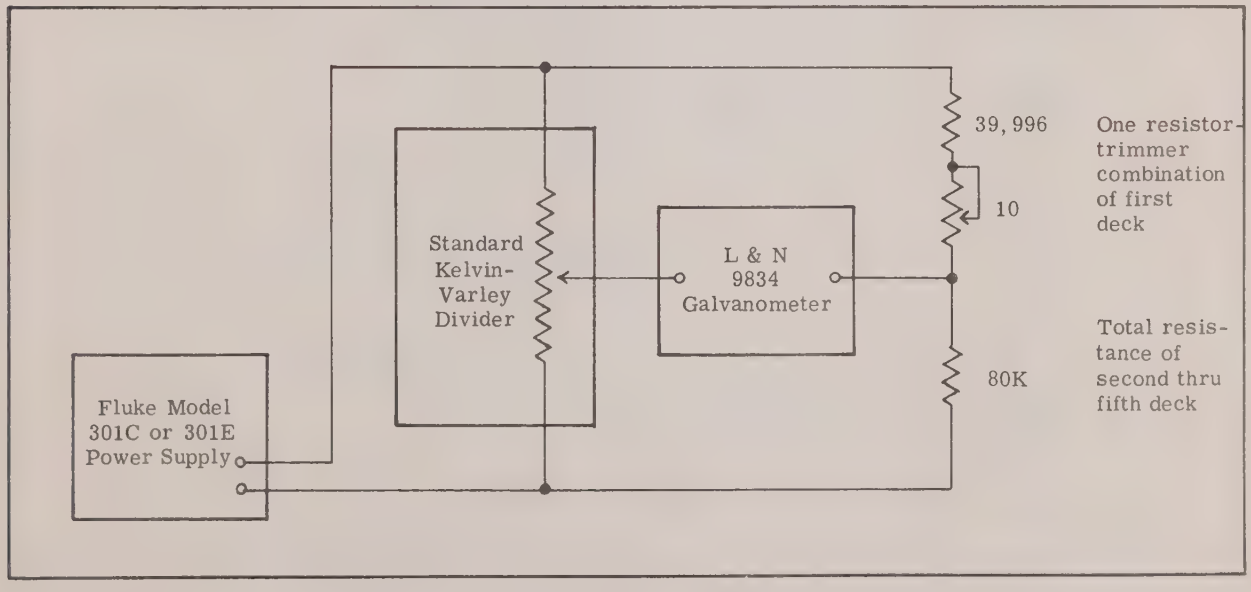


Figure 4-9. KELVIN-VARLEY DIVIDER CALIBRATION

SECTION V

LIST OF REPLACEABLE PARTS

5-1. GENERAL

a. The following eight assembly lists describe all normally replaceable parts of the Model 823A, 823AR, 823A/AG, and 823AR/AG Differential AC/DC Voltmeters. Each list has a corresponding illustration on which the parts for that list are pointed out. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke Stock Number.

b. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the 823A. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section.

5-2. HOW TO OBTAIN PARTS

a. Standard components have been used whenever possible. Thus, most parts may be obtained locally. However, special components are used in some instances. All parts manufactured or altered by Fluke and all parts for which Fluke controls the design are designated by an asterisk preceding the Fluke stock number. All structural parts and special parts should be purchased from your local Fluke representative or from the factory.

b. When ordering parts always include:

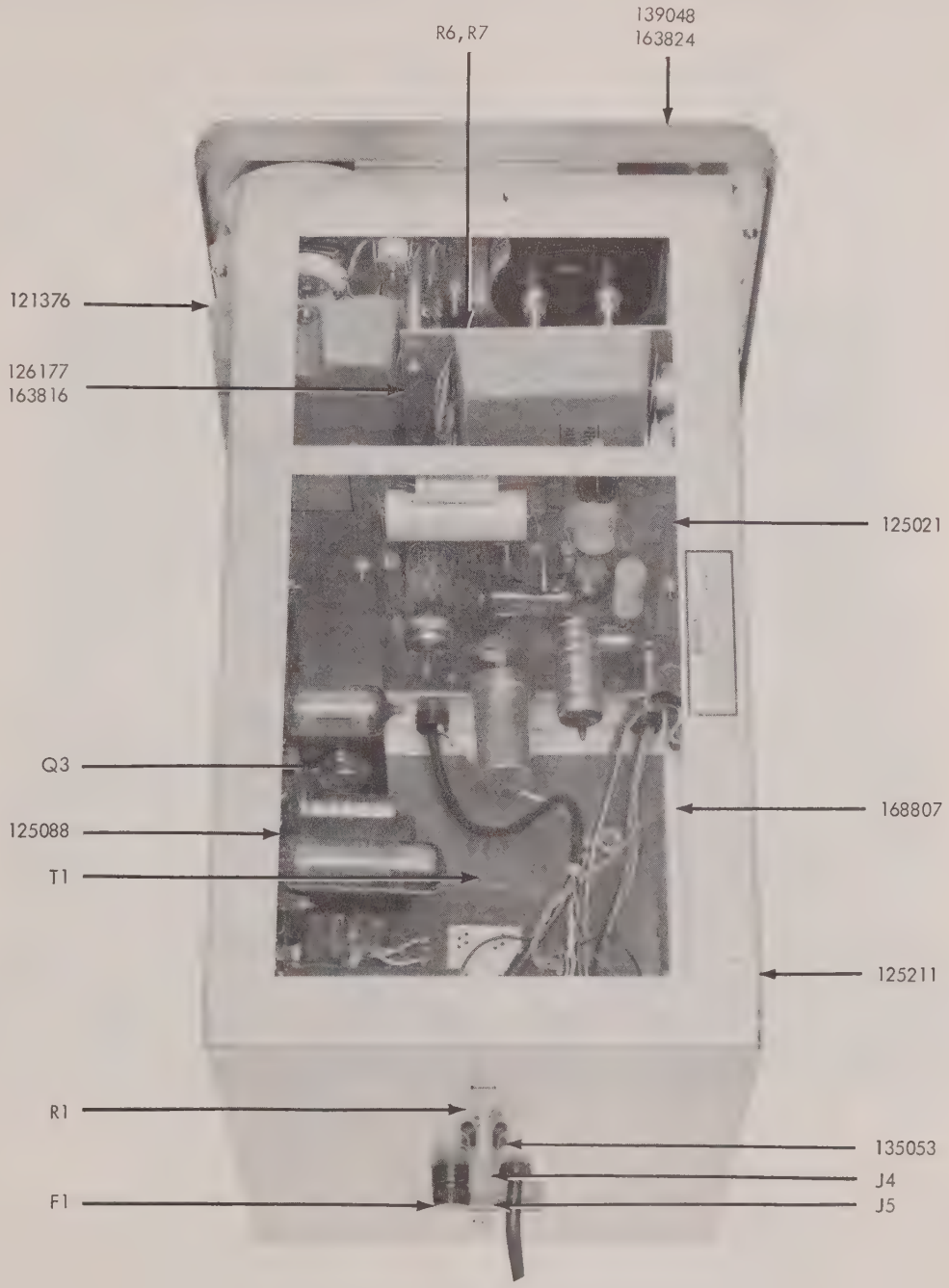
(1) Reference designation, description, and Fluke stock number.

(2) Instrument model and serial number.

(3) Most structural parts are not listed. In this case, give complete description, function, and location for the part.

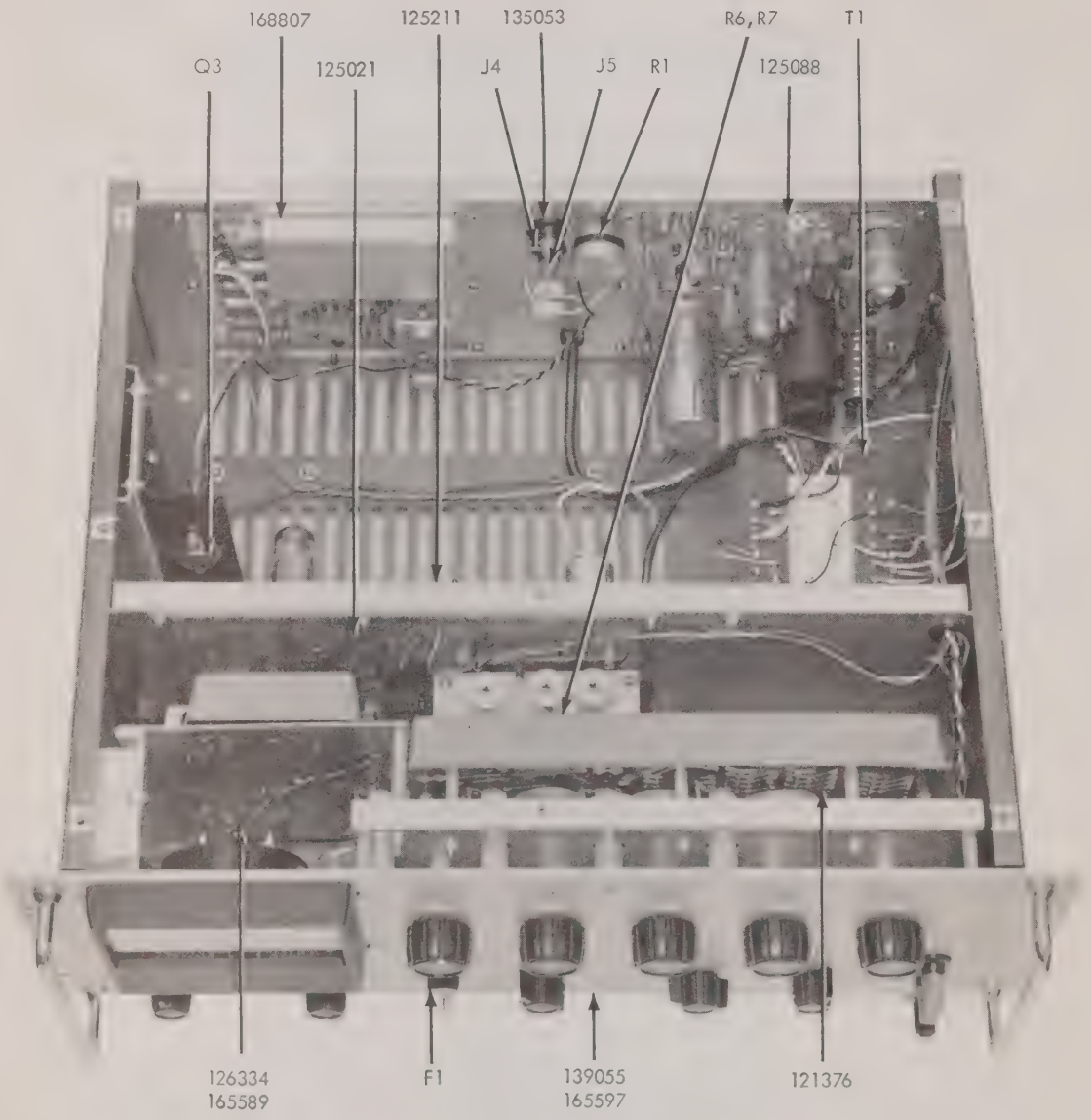
REFERENCE DESIGNATION	DESCRIPTION		FLUKE STOCK NO.	USE CODE
	Final Assembly (Cabinet model, standard cell option)		*823A	
	(Rack model, standard cell option)		*823AR	
	(Cabinet model, Zener diode option)		*823A/AG	
	(Rack model, Zener diode option)		*823AR/AG	
	Front Panel Assembly (See figure 5-2)	(823A)	*139048	
		(823AR)	*139055	
		(823A/AG)	*163824	
		(823AR/AG)	*165597	
	Reference Supply Board Assembly (See figure 5-3)		*125088	
	Null Detector Chassis Assembly (See figure 5-4)		*125229	K
			*168807	L
	Range Resistor Board Assembly (See figure 5-5)	(823A)	*126177	
		(823AR)	*126334	
		(823A/AG)	*163816	
		(823AR/AG)	*165589	
	Kelvin-Varley Resistor Board Assembly (See figure 5-6)		*121376	
	Converter/AC Range Switch Assembly (See figure 5-7)		*125021	
	Chopper Drive Board Assembly (See figure 5-8)		*125211	K

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
F1	Fuse, 1.5 ampere, slow blowing (for 115 volt operation)	109231	
	Fuse, 0.75 ampere, slow blowing (for 230 volt operation)	109256	
	Fuse holder	100107	
J4, J5	Binding post, red	104158	
	Binding post insulator, dual, black	*135053	
Q3	Transistor, germanium, PNP	*116707	
R1	Resistor, variable wirewound, 10K ±10%, 2W	111617	
R6, R7	Resistor, wirewound, 6K ±5%, 5W	113449	
T1	Transformer, power	*121418	K
		*161216	L
	Line cord, 3 wire	102822	
	Rubber foot	101253	
	Case Assembly (Cabinet model)	*120386	
	Handle, flexible black vinyl, 5-1/2" (Cabinet model)	407-101	



CABINET MODEL

Figure 5-1. FINAL ASSEMBLY (sheet 1 of 2)



RACK MODEL

Figure 5-1. FINAL ASSEMBLY (sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Front Panel Assembly (823A)	*139048	
	(823AR)	*139055	
	(823A/AG)	*163824	
	(823AR/AG)	*165597	
B1	Standard cell	135160	
C1	Capacitor, plastic, 0.47 uf ±10%, 600V	105494	
DS1, DS2, DS3, DS4	Lamp, decimal	102855	
	Light holder	100131	
	Light shield	101428	
	Light lens	103440	
J1, J2	Binding post, red	104158	
	Binding post, insulator, dual, black	*135053	
	Binding post, insulator, black (Cabinet model)	*135061	
	Shorting link	101220	
J3	Binding post, black	101204	
	Binding post, spacer	101212	
M1	Meter, 100-0-100 microamp	*111211	
R2 thru R5	Resistor, carbon film, 10 Meg ±1%, 1W	107748	
R6	Resistor, carbon film, 9 Meg ±1%, 1W	107557	
R7	Resistor, carbon film, 900K ±1%, 1/2W	107391	
R8	Resistor, carbon film, 90K ±1%, 1/2W	107292	
R9	Resistor, carbon film, 9K ±1%, 1/2W	107250	
R10	Resistor, carbon film, 900Ω ±1%, 1/2W	107771	
R11	Resistor, carbon film, 100Ω ±1%, 1/2W	107730	
R12	Resistor, variable wirewound, dual section 1K and 100Ω ±10%, 2W	112714	
S1	Switch, power	114850	
S2	Switch, range, DC section	*125138	
S3	Switch, null	*121483	
S4	Switch, operate-calibrate	*134973	
S5	Switch, AC - DC polarity	*126193	
S6	Switch, voltage dial A	*134817	
S7, S8, S9	Switch, voltage dials B, C, and D	*134841	
S10	Switch, voltage dial E	*134825	
	Knob	101287	O
		188524	P
		188540	P
	Knob	101121	O
		171660	P
	Knob	101311	O
		188524	P
	Knob	103614	O
		188532	P
	Voltage dial plates (Cabinet model)	107029	
	(Rack model)	107011	
	Handle, 6" chrome plated (rack model)	101717	

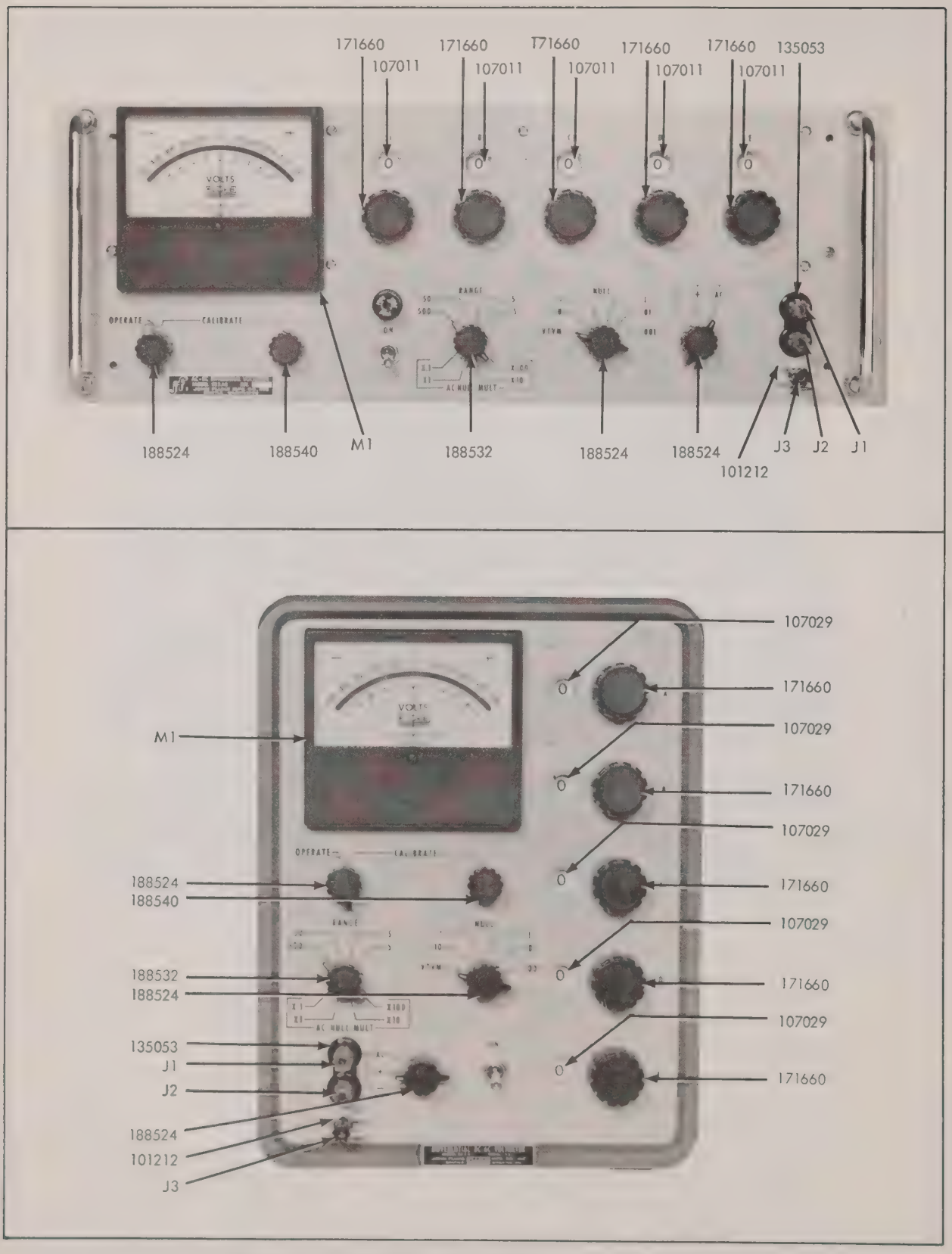
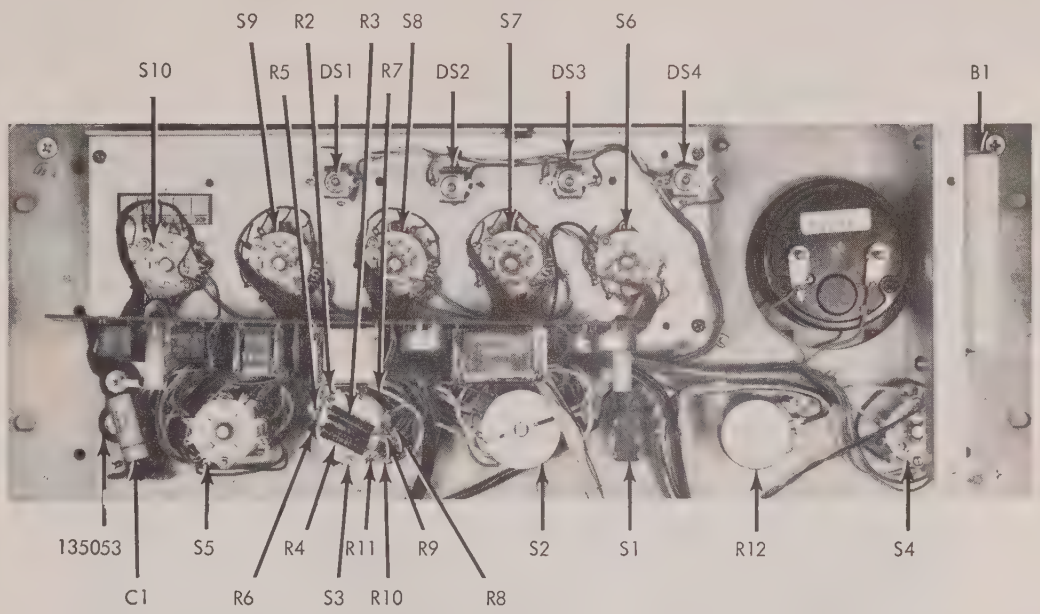


Figure 5-2. FRONT PANEL ASSEMBLY (sheet 1 of 2)



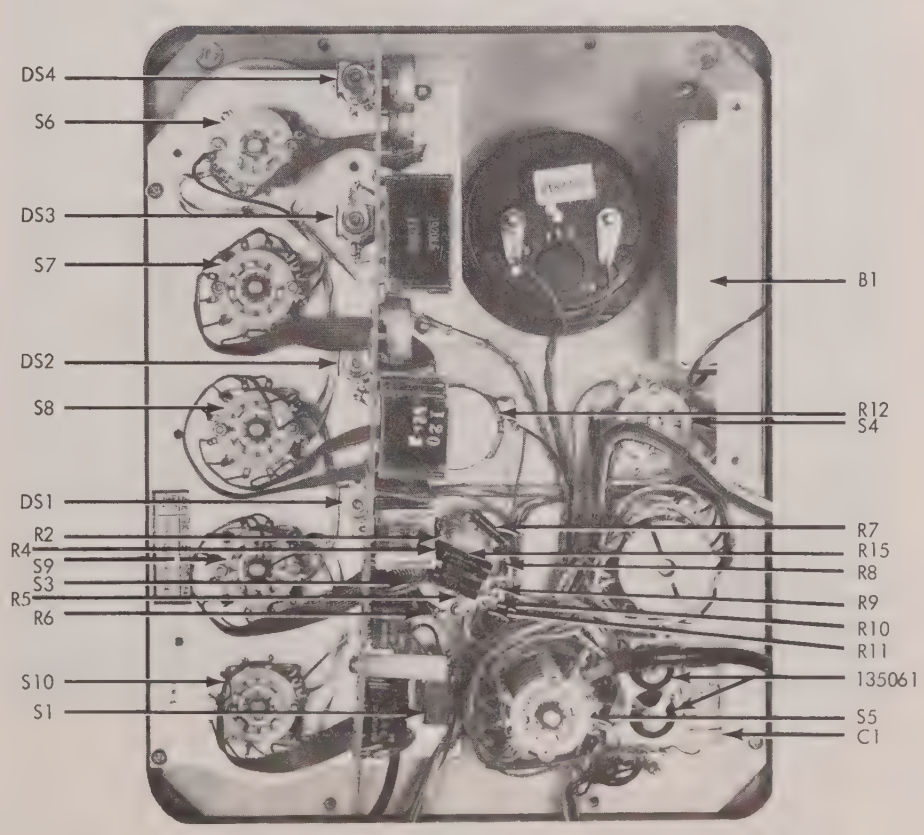


Figure 5-2. FRONT PANEL ASSEMBLY (sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Reference Supply Board Assembly without tubes	*125088	
C101, C102	Capacitor, electrolytic, 20 uf -10/+10%, 500V	105932	
C103	Capacitor, electrolytic, 4000 uf -10/+100%, 15V	105163	
C104	Capacitor, paper, 0.1 uf ±20%, 400V	105312	
C105	Capacitor, plastic, 0.033 uf ±20%, 600V	105916	
C106	Capacitor, plastic, 0.1 uf ±20%, 600V	105833	
C107	Capacitor, ceramic, 0.01 uf -20/+80%, 500V	105668	
CR101 thru CR103	Diode, silicon, 0.750 Amp, 600 PIV	112680	E
	Diode, silicon, 0.750 Amp, 600 PIV	112383	F
CR104, CR105	Diode, silicon, 1 Amp, 50 PIV	112409	I
	Diode, silicon, 1 Amp, 100 PIV	116111	J
Q1	Transistor, germanium, NPN, 2N214	116137	
	Transistor, silicon, NPN, 2N3712	*117267	B
Q2	Transistor, germanium, PNP, 2N1372	116129	
R101	Resistor, composition, 1 Meg ±10%, 1/2W	108134	
R102	Resistor, composition, 220K ±10%, 1/2W	108217	
R104	Resistor, carbon film, 5K ±1%, 1/2W	107110	A
	Resistor, carbon film, 5.44K ±1%, 1/2W	107235	B
R105	Resistor, carbon film, 135K ±1%, 1/2W	107201	A
	Resistor, carbon film, 125K ±1%, 1/2W	107433	B
R106	Resistor, composition, 8.2K ±10%, 1/2W	109017	
R107, R108	Resistor, carbon film, 50Ω ±1%, 1/2W	107037	
R109, R110	Resistor, composition, 270K ±10%, 1W	109512	
R111	Resistor, composition, 22 Meg ±10%, 1/2W	108233	
R112	Resistor, composition, 15 Meg ±10%, 1/2W	108647	
R113	Resistor, composition, 10 Meg ±10%, 1/2W	108142	
R114	Resistor, composition, 100K ±10%, 1W	109397	
R115	Resistor, wirewound, 140K ±3%, 10W	112417	
R116	Resistor, composition, 100K ±10%, 1/2W	108126	
R117	Resistor, composition, 560K ±10%, 1W	109678	
R118	Resistor, composition, 220K ±10%, 1/2W	108217	
R119	Resistor, composition, 330Ω ±10%, 1/2W	108589	
R120	Resistor, composition, 220K ±10%, 1W	109652	
R121	Resistor, variable wirewound, 5K ±20%, 1-1/4W	111609	
R122	Resistor, composition, 560K ±10%, 1W	109678	
R123	Resistor, wirewound, 386K ±0.5%, 1W	112482	
R124	Resistor, wirewound, 76K ±0.5%, 1/2W	111948	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R125	Resistor, composition, 82K ±10%, 1/2W	108498	
V101	Vacuum tube, pentode, EL84/6BQ5	116616	
V102	Vacuum tube, voltage reference, aged OG3	116749	
V103	Lamp, neon glow, NE2E Lamp, neon glow, NE83	100347 170167	M N
V104, V105	Vacuum tube, duo triode, 12AX7	115956	

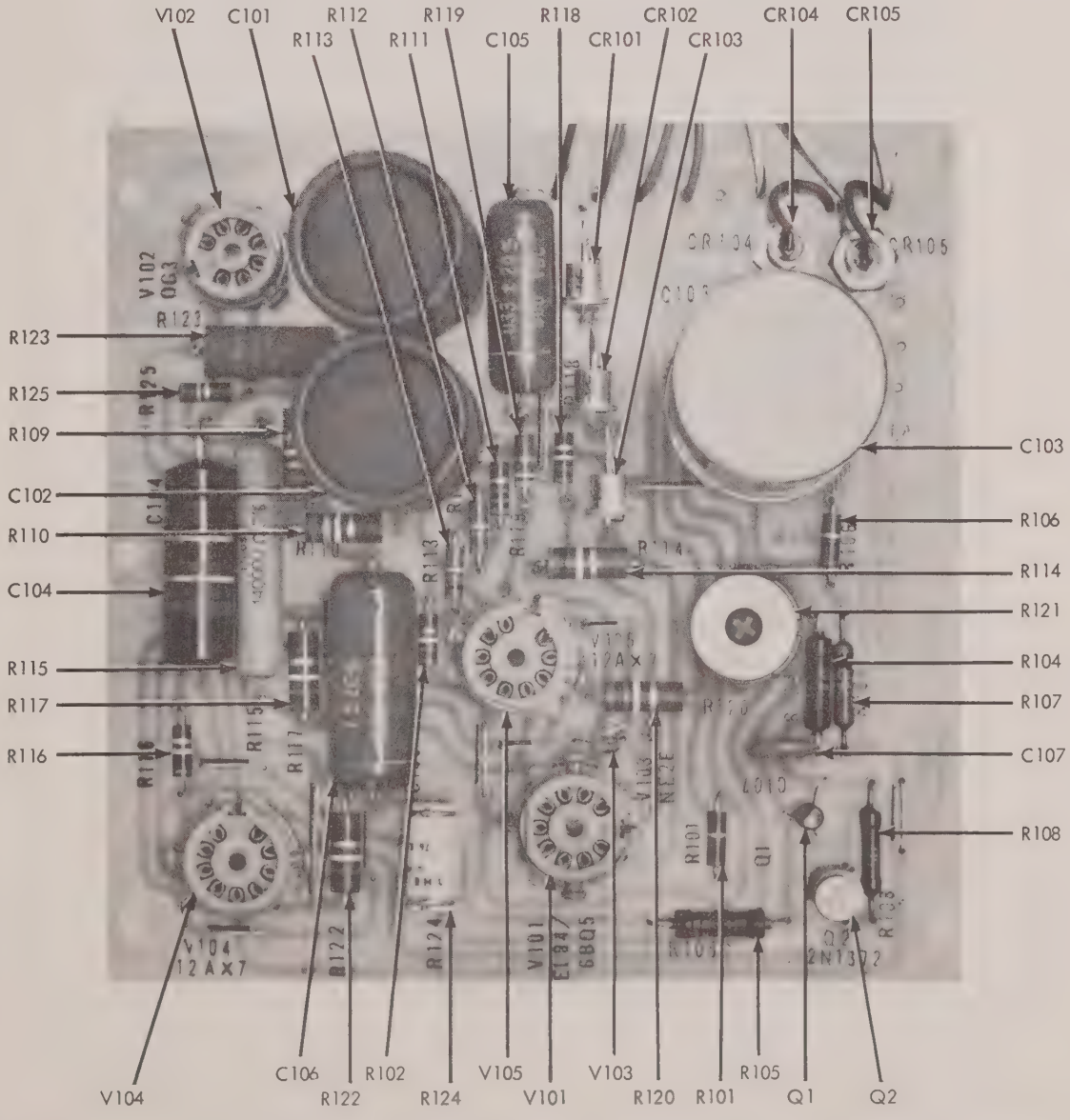


Figure 5-3. REFERENCE SUPPLY BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	NOTE: This assembly applies to 823A & 823A/AG serial numbers 123 to 502 and 823AR & 823AR/AG serial numbers 123 to 326.		
	Null Detector Chassis Assembly without tubes	*125229	
C201, C202	Capacitor, plastic, 0.1 uf ±20%, 100V	106526	
C203	Capacitor, paper, 0.047 uf ±20%, 400V	105718	
C204 ABC	Capacitor, electrolytic, 40-20-20 uf -10/+100%, 250V	106542	
C205	Capacitor, plastic, 0.1 uf ±20%, 200V Capacitor, plastic, 0.1 uf ±20%, 200V	106310 106435	C D
C206	Capacitor, electrolytic, 100 uf -10/+100%, 3V	106534	
C207	Capacitor, ceramic, 0.005 uf ±20%, 500V	105650	
C208	Capacitor, plastic, 0.1 uf ±20%, 200V Capacitor, plastic, 0.1 uf ±20%, 200V	106310 106435	C D
C209	Capacitor, plastic, 0.47 uf ±20%, 200V	106419	
C210	Capacitor, plastic, 0.1 uf ±20%, 200V Capacitor, plastic, 0.1 uf ±20%, 200V	106310 106435	C D
C211	Capacitor, electrolytic, 5 uf -10/+100%, 50V	106500	
C212	Capacitor, electrolytic, 500 uf -10/+100%, 3V	106328	
C213 AB	Capacitor, electrolytic, 20-20 uf -10/+50%, 450V	105064	
C214	Capacitor, electrolytic, 2000 uf -10/+100%, 25V	105171	
C215	Capacitor, electrolytic, 30 uf -10/+100%, 15V	106492	
C216	Capacitor, electrolytic, 15 uf -10/+150%, 6V	105700	
CR201	Diode, silicon, 0.75 Amp, 600 PIV Diode, silicon, 0.75 Amp, 600 PIV	112680 112383	E F
CR202	Diode, silicon, type 2E4, 300 ma, 400 PIV	116111	
CR203	Diode, silicon, 0.75 Amp, 600 PIV Diode, silicon, 0.75 Amp, 600 PIV	112680 112383	E F
CR204, CR205	Diode, silicon, type 2E4, 300 ma, 400 PIV	116111	
G1	Chopper, electromechanical, SPDT	104455	
Q201	Transistor, germanium PNP, special purpose 2N301W	*116707	
Q202	Transistor, germanium PNP, 2N1372	116129	
R201 thru R203	Resistor, composition, 820K ±10%, 1/2W	108357	
R204	Resistor, composition, 2.2 Meg ±10%, 1/2W	108225	
R205	Resistor, composition, 22K ±10%, 1/2W	108209	
R206	Resistor, composition, 150K ±10%, 1/2W	108167	
R207	Resistor, composition, 4.7K ±10%, 1/2W	108381	
R208	Resistor, composition, 10 Meg ±10%, 1/2W	108142	
R209	Resistor, composition, 10K ±10%, 1/2W	108118	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R210	Resistor, composition, 220K ±10%, 1/2W	108217	
R211, R212	Resistor, composition, 1 Meg ±10%, 1/2W	108134	
R213	Resistor, composition, 180K ±10%, 1/2W	108431	
R214	Resistor, composition, 1K ±10%, 1/2W	108563	
R215	Resistor, composition, 3.3 Meg ±10%, 1/2W	108282	
R216	Resistor, composition, 1.5 Meg ±10%, 1/2W	108175	
R217	Resistor, composition, 4.7K ±10%, 1/2W	108381	
R218	Resistor, composition, 22K ±10%, 1/2W	108209	
R219	Resistor, composition, 220Ω ±10%, 1/2W	108191	
R220	Resistor, carbon film, 10Ω ±1%, 1/2W	107789	
R221	Resistor, carbon film, 75Ω ±1%, 1/2W	107045	
R222	Resistor, variable wirewound, 500Ω ±10%, 2W	111773	
R223, R224	Resistor, composition, 1.8K ±10%, 1/2W	108860	
R225, R226	Resistor, composition, 47K ±10%, 2W	110015	
R227	Resistor, composition, 2.2K ±10%, 2W	109967	
R228	Resistor, composition, 560K ±10%, 1/2W	108795	
R229	Resistor, composition, 560Ω ±10%, 1/2W	108316	
R230	Resistor, composition, 2.2K ±10%, 2W	109967	
R231	Resistor, composition, 180K ±10%, 1/2W	108431	
R232	Resistor, variable wirewound, 10K ±20%, 2W	111617	
R233	Resistor, composition, 100K ±10%, 1/2W	108126	
R234	Resistor, carbon film, 2.7K ±1%, 1/2W	107276	
R235	Resistor, carbon film, 31.6K ±1%, 1W	107797	
R236	Resistor, composition, 22K ±10%, 1/2W (may be omitted)	108209	
V201	Lamp, neon glow, type NE2E, 1/10W	100347	
V202	Vacuum tube, duo triode, 5751	116657	
V203	Vacuum tube, triode-pentode, 6AW8A	116434	
V204	Vacuum tube, voltage reference, OA2	115873	
	Vacuum tube shield	101808	
	Vacuum tube clamp, 2 inches high	102178	

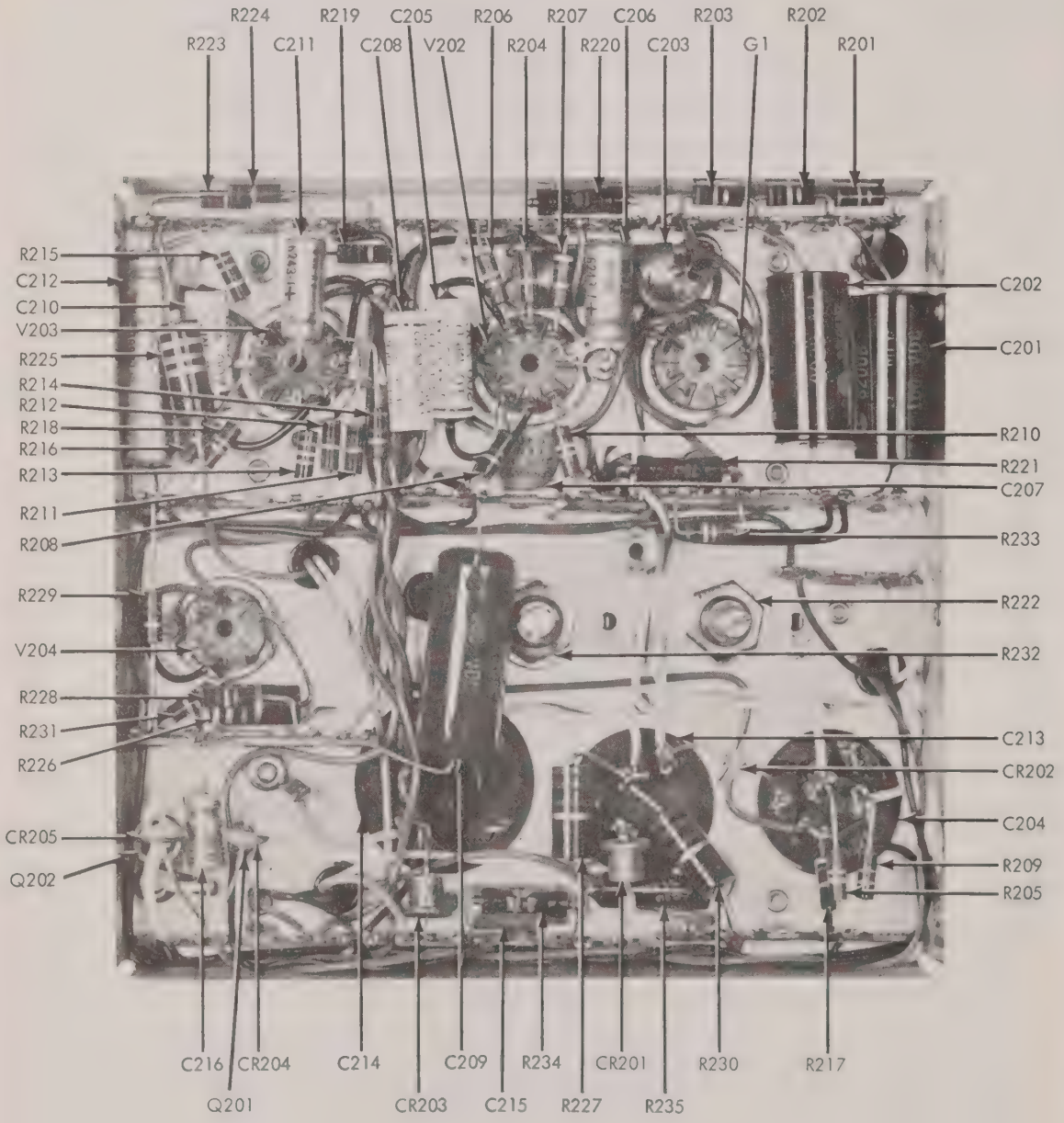


Figure 5-4. NULL DETECTOR ASSEMBLY (sheet 1 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	NOTE: This assembly applies to 823A & 823A/AG serial numbers 503 and on and 823AR & 823AR/AG serial numbers 327 and on.		
	Null Detector Board Assembly	168807	
	Chopper Drive Assembly	168815	
C212	Capacitor, plastic, 0.047 uf ±20%, 100V	106096	
DS202, DS203	Lamp, neon glow, type NE2U	*162602	
R226	Resistor, variable composition, 100K ±30%, 3/10W	163402	
R227, R228	Resistor, composition, 390K ±10%, 1/2W	108993	
C201, C202	Capacitor, electrolytic, 0.22 uf ±20%, 100V coated with epoxy resin	167452	
C203	Capacitor, plastic, 0.047 uf ±20%, 100V (Use 162008)	106096	Q
	Capacitor, plastic, 0.047 uf ±20%, 250V	162008	R
C204	Capacitor, ceramic, 180 pf ±10%, 500V	105890	
C205	Capacitor, electrolytic, 1250 uf -10/+50%, 4V	166330	
C206	Capacitor, electrolytic, 400 uf -10/+50%, 25V	168153	
C207	Capacitor, plastic, 0.1 uf ±10%, 200V	106013	
C208	Capacitor, plastic, 0.0047 uf ±20%, 200V	106054	
C209	Capacitor, electrolytic, 5 uf -10/+75%, 25V	152009	
C210	Capacitor, electrolytic, 1250 uf -10/+50%, 4V	166330	
C211	Capacitor, electrolytic, 10 uf -10/+50%, 25V	170266	
C213, C214	Capacitor, electrolytic, 400 uf -10/+50%, 25V	168153	
CR201 thru CR203	Diode, silicon, 1 Amp, 100 PIV	116111	
DS201	Lamp, neon glow, type NE2U coated with epoxy resin	*162776	
Q201	Transistor, silicon, NPN, Type S7563 (Use 177105)	168716	Q
	Transistor, silicon, NPN, Type 2N3565	177105	R
Q202 to Q206	Transistor, silicon, NPN, Type 2N3391	168708	
Q207	Transistor, silicon, PNP, Type 2N3638	169375	
R201	Resistor, composition, 270K ±10%, 1W (Use 110023)	109512	Q
	Resistor, composition, 270K ±10%, 2W	110023	R
R202	Resistor, composition, 470K ±10%, 1/2W	108290	
R203	Resistor, metal film, 10.7Ω ±1%, 1/2W	168740	
R204	Resistor, composition, 68Ω ±10%, 1/2W	108464	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R205	Resistor, variable wirewound, 500Ω ±10%, 1-1/4W	112433	
R206	Resistor, composition, 10K ±10%, 1/2W	108118	
R207	Resistor, composition, 1M ±10%, 1/2W	108134	
R208	Resistor, composition, 10M ±10%, 1/2W	108142	
R209	Resistor, composition, 100K ±10%, 1/2W	108126	
R210	Resistor, composition, 2.2M ±10%, 1/2W	108225	
R211	Resistor, composition, 270K ±10%, 1/2W	108258	
R212	Resistor, variable composition, 100K ±20%, 1/4W	163873	
R213	Resistor, composition, 10Ω ±10%, 1/2W	108092	
R214	Resistor, composition, 180K ±10%, 1/2W	108431	
R215	Resistor, composition, 10K ±10%, 1/2W	108118	
R216	Resistor, composition, 180K ±10%, 1/2W	108431	
R217	Resistor, composition, 100K ±10%, 1/2W	108126	
R218	Resistor, composition, 27K ±10%, 1/2W	108878	
R219	Resistor, composition, 47K ±10%, 1/2W	108480	
R220	Resistor, composition, 100Ω ±10%, 1/2W Resistor, composition, 200Ω ±10%, 1/2W	108100 108191	S T
R221	Resistor, composition, 270K ±10%, 1/2W	108258	
R222	Resistor, composition, 18K ±10%, 1/2W	108183	
R223	Resistor, composition, 2.2K ±10%, 1/2W	108605	
R224, R225	Resistor, composition, 47K ±10%, 1/2W	108480	
R229	Resistor, composition, 100Ω ±10%, 1/2W	108100	
R230	Resistor, composition, 47K ±10%, 1/2W	108480	
V201, V202	Photoelectric cell	167940	
V203	Photoelectric cell	167940	S
	Photoelectric cell	200261	T

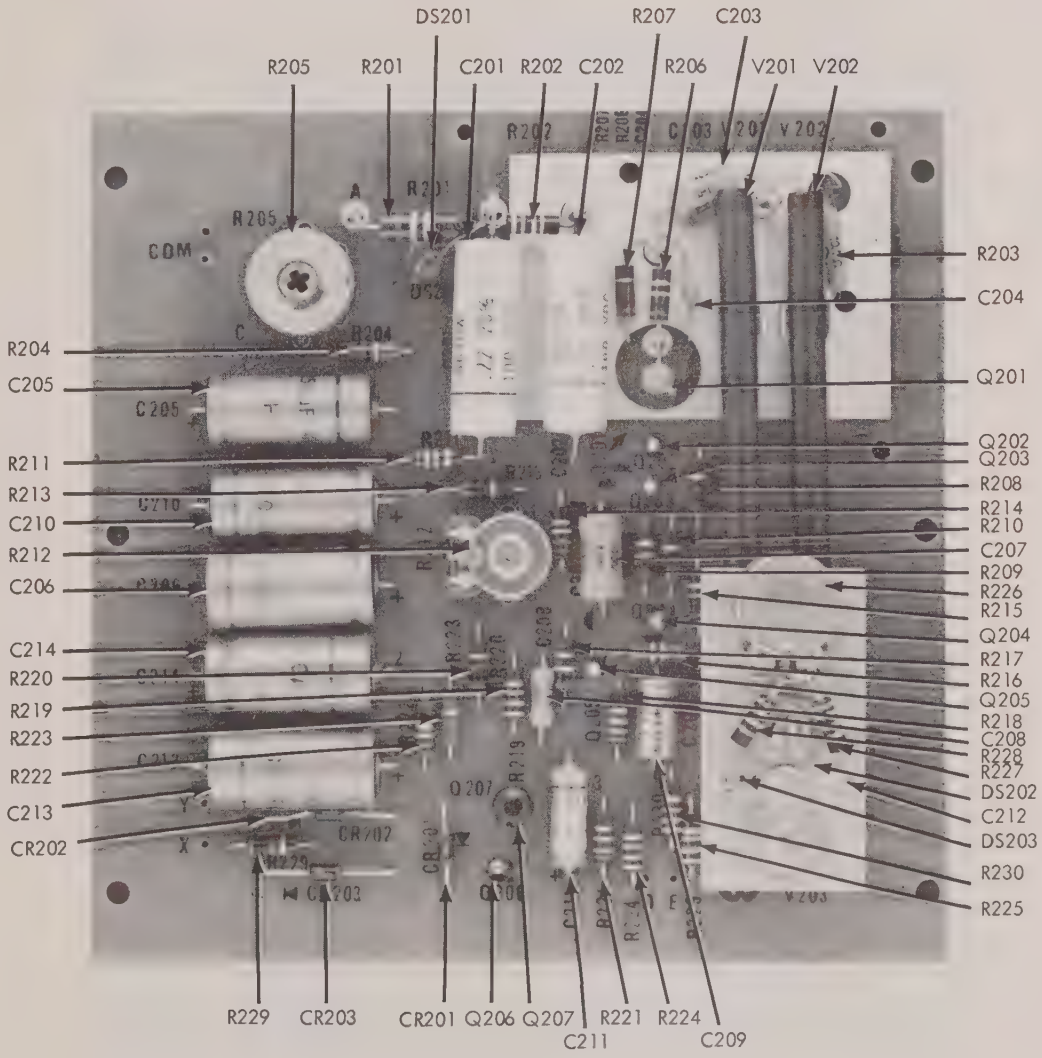


Figure 5-4. NULL DETECTOR ASSEMBLY (sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Range Resistor Board Assembly (823A) (823AR) (823A/AG) (823AR/AG)	*126177 *126334 *163816 *165589	
C301	Capacitor, plastic, 1 uf ±20%, 600V	105924	
C302	Capacitor, plastic, 2 uf ±20%, 200V	106443	
R311 thru R315	Resistor, composition, 22 Meg ±10%, 1/2W	108233	
R318	Resistor, variable wirewound, 350Ω ±10%, 1-1/4W	113100	
R322	Resistor, composition, 12K ±10%, 1/2W	108977	
R323, R326, R329	Resistor, variable wirewound, 150" ±10%, 1-1/4W	113092	
R331	Resistor, composition, 270Ω ±10%, 1/2W	108241	
	Matched Resistor Set (823A and 823AR)	*121400	
R316, R317	Resistor, wirewound, 74.975K ±0.015%, 1/2W	**	
R319	Resistor, wirewound, 459.8Ω ±0.025%, 1/2W	**	
R320, R321	Resistor, wirewound, 74.975K ±0.015%, 1/2W	**	
R324	Resistor, wirewound, 28.571K ±0.015%, 1/2W	**	
R327	Resistor, wirewound, 2298.8Ω ±0.015%, 1/8W	**	
R328	Resistor, wirewound, 74.975K ±0.015%, 1/2W	**	
R330	Resistor, wirewound, 225.45Ω ±0.015%, 1/8W	**	
R332	Resistor, wirewound, 74.975K ±0.015%, 1/2W	**	
	Zener-Resistor Set (823A/AG and 823AR/AG)		
CR301	Zener Diode (If replacement is required, CR301, R14, R15, R316, R317, R319, and R332, must be replaced with Zener-resistor replacement set 184358.		
R13	Resistor, composition, 4.7K ±10%, 1/2W	108381	
R14	Resistor, composition (Optimum value is selected at factory to match Zener diode. If replacement is required, replace with a resistor of same value as determined by color code.)		
R15	Resistor, wirewound (Optimum value is selected at factory to match Zener diode)	**	
R313, R317	Resistor, wirewound, 74.975K ±0.015%, 1/2W	**	
R319	Resistor, wirewound, 2778 to 2964.45Ω, 0.02W (Optimum value is selected at factory to match Zener diode)	**	
R320, R321	Resistor, wirewound, 74.975K ±0.015%, 1/2W	**	
R324	Resistor, wirewound, 28.571K ±0.015%, 1/2W	**	
R327	Resistor, wirewound, 2298.8Ω ±0.015%, 1/8W	**	
R328	Resistor, wirewound, 74.975K ±0.015%, 1/2W	**	
R330	Resistor, wirewound, 225.45Ω ±0.015%, 1/8W	**	
R332	Resistor, wirewound, 74.975K ±0.015%, 1/2W	**	
	Plastic cover	*121442	

**These resistors are factory matched for each instrument. When ordering, include all information stamped on resistor.

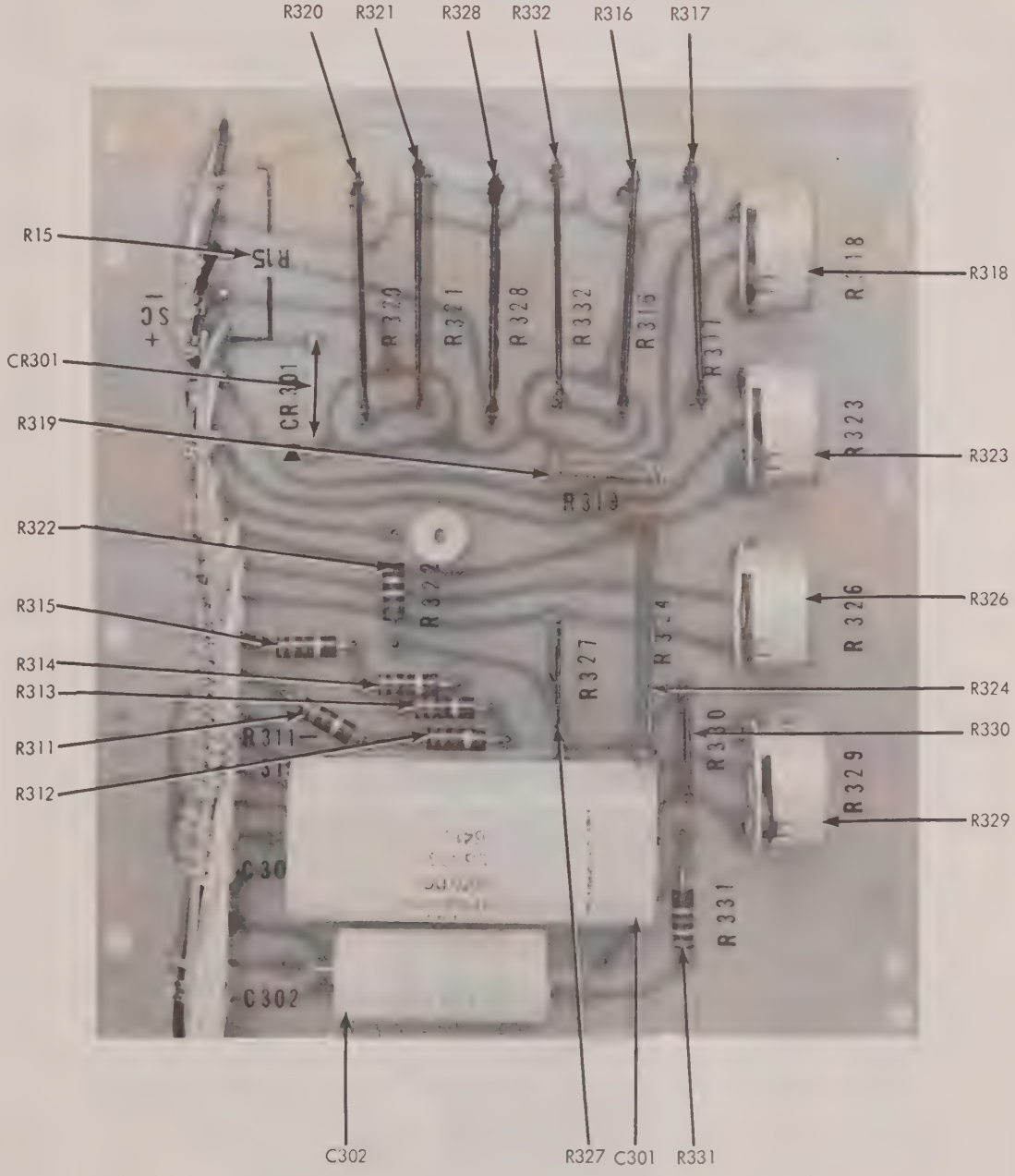


Figure 5-5. RANGE RESISTOR BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Kelvin Varley Resistor Board Assembly	*121376	
R401 thru R406**	Resistor, wirewound 40K ±0.02%, 1/2W	*146530	
R407 thru R417**	Resistor, wirewound 8K ±0.005%, 1/2W	*131946	
R418 thru R428**	Resistor, wirewound 1.6K ±0.01%, 1/8W	*131953	
R429 thru R439**	Resistor, wirewound 320Ω ±0.02%, 1/8W	*146159	
R440 thru R449**	Resistor, wirewound 64Ω ±0.1%, 1/8W	*146167	
R450 thru R455	Resistor, variable wirewound, 10Ω ±20%, 1-1/4W	112672	
	Plastic cover	147595	

** These resistors are factory matched for each instrument.

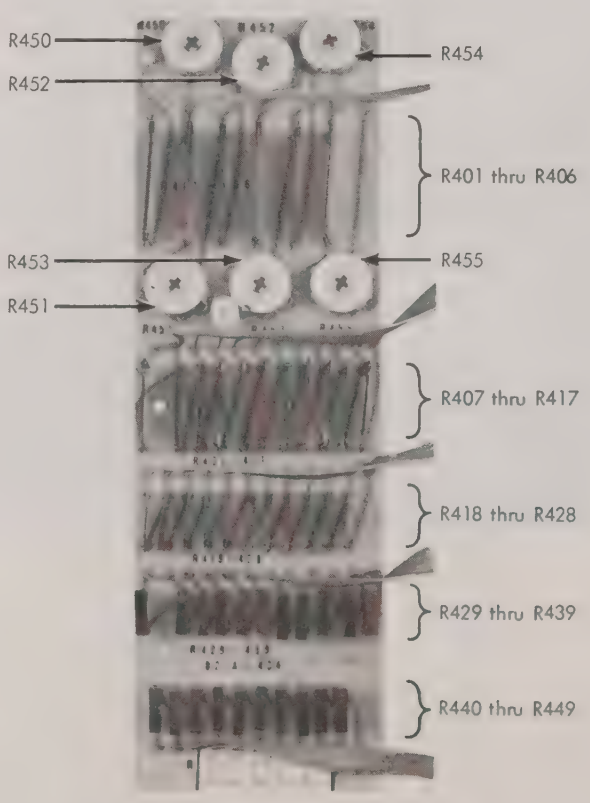


Figure 5-6. KELVIN-VARLEY RESISTOR BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Converter/AC Range Switch Assembly	*125021	
CR501, CR502	Diode, silicon, 60 ma (matched pair)	*182428	
	Converter Assembly	*125039	
C505AB	Capacitor, electrolytic, 10-10 uf -10/+50%, 500V	105130	
C506	Capacitor, ceramic, 0.005 uf ±20%, 500V	105650	
C507	Capacitor, ceramic, 300 uf ±10%, 500V	105734	
C508	Capacitor, plastic, 0.47 uf ±20%, 200V	106419	
C509	Capacitor, plastic, 0.0068 uf ±20%, 400V	106591	
C510	Capacitor, ceramic, 500 uuf -0%, 500V	105692	
C511	Capacitor, plastic, 0.47 uf ±20%, 200V	106419	
C512	Capacitor, paper, 0.1 uf ±20%, 400V	105312	
C513	Capacitor, electrolytic, 20 uf -10/+100%, 50V	106229	
C514	Capacitor, ceramic, 2.2 uf -0%, 3V	106393	
C515	Capacitor, plastic, 2 uf ±20%, 200V	106443	
C516	Capacitor, paper, 1 uf ±20%, 600V	105924	
C517	Capacitor, plastic, 5 uf ±20%, 200V (if replacement is required, it will be necessary to replace 106468 with 106997 and C503, 106740 with 107003)	106468	C
	Capacitor, plastic, 5 uf ±5%, 200V	106997	D
C518	Capacitor, plastic, 2 uf ±20%, 200V	106443	
C522	Capacitor, electrolytic, 500 uf -10/+100%, 3V	106328	
CR503	Diode, silicon, 1 amp, 100 PIV	116111	
R506, R507	Resistor, metal film, 68K ±5%, 2W	111112	
R508	Resistor, metal film, 56K ±5%, 2W	111104	
R509	Resistor, metal film, 100K ±5%, 5W	111195	
R510, R511	Resistor, composition, 3.3K ±10%, 1/2W	108373	
R512	Resistor, composition, 220Ω ±10%, 1/2W	108191	
R513	Resistor, composition, 270Ω ±10%, 1/2W	108241	
R514	Resistor, composition, 1.8 Meg ±10%, 1/2W	108720	
R515	Resistor, composition, 2.2 Meg ±10%, 1/2W	108225	
R516	Resistor, composition, 15 Meg ±10%, 1/2W	108647	
R517	Resistor, composition, 18 Meg ±10%, 1/2W	108985	
R518	Resistor, composition, 1.8 Meg ±10%, 1/2W	108720	
R519	Resistor, composition, 47Ω ±10%, 1/2W	108688	
R520	Resistor, metal film, 120K ±5%, 2W	111120	
R521	Resistor, composition, 180Ω ±10%, 1/2W	108571	
R522	Resistor, composition, 10K ±10%, 1/2W	108118	
R523	Resistor, composition, 390Ω ±10%, 1/2W	108365	
R524	Resistor, composition, 330K ±10%, 1/2W	108274	
R525	Resistor, composition, 470K ±10%, 1/2W	108290	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R526	Resistor, composition, 220K ±10%, 1/2W	108217	
R527	Resistor, composition, 47Ω ±10%, 1/2W	108688	
R528	Resistor, metal film, 150K ±5%, 2W	111138	
R529	Resistor, composition, 100K ±10%, 1W	109397	
R530	Resistor, metal film, 47K ±5%, 5W	111187	
R531	Resistor, composition, 220Ω ±10%, 1/2W	108191	
R532	Resistor, composition, 470K ±10%, 1/2W	108290	
R536	Resistor, variable wirewound, 500Ω ±10%, 1/4W	111781	
R537	Resistor, carbon film, 100K ±1%, 1/2W	107185	
R538	Resistor, wirewound, 21.28K ±0.1%, 1/2W	113217	
R539	Resistor, wirewound, 490Ω ±0.1%, 1/2W	112805	
R545	Resistor, variable wirewound, 25Ω ±10%, 1-1/4W	113431	
V501	Vacuum tube, pentode, 6EJ7	116699	
V502	Vacuum tube, triode-pentode, 6AW8A	116434	
	AC Range Switch Assembly	*125047	
	AC-Range-Switch Gain Adjust Assembly	*125047-1	
R533	Resistor, variable wirewound 100Ω ±20%, 1-1/4W	112797	
R541	Resistor, variable wirewound 50Ω ±20%, 1-1/4W	112490	
R544	Resistor, variable wirewound 10Ω ±20%, 1-1/4W	112672	
	AC-Range-Switch Attenuator Assembly	*125047-2	
C501	Capacitor, variable glass 0.8 to 8.5 uuf, 1250V	106872	
C502	Capacitor, ceramic, 39 uuf ±2%, 600V	105627	
C503	Capacitor, plastic, 0.18 uf ±10%, 600V (If replacement is required, it will be necessary to replace 106740 with 107003 and C517, 106468 with 106997)	106740	C
	Capacitor, plastic, 0.12 uf ±5%, 600V	107003	D
C521	Capacitor, ceramic, 300 uuf ±5%, 600V	105601	
C523	Capacitor, variable glass 0.8 to 8.5 uuf, 1250V	106872	
C524	Capacitor, ceramic, 5 uuf ±10%, 500V Capacitor, ceramic, 7.5 uuf ±10%, 500V	106955 159939	G H
R503	Resistor, variable wirewound 5K ±10%, 1/4W	111765	
R535	Resistor, variable wirewound 500 ±10%, 1/4W	111781	
	Matched Resistor Set	*107987	
R501	Resistor, metal film, 1 Meg ±1/2%, 1W		
R502	Resistor, metal film, 122.6K ±1%, 1/2W		
R534	Resistor, metal film, 10K ±1%, 1/2W		

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	AC-Range-Switch Gain Network Assembly	*125047-3	
C504, C519	Capacitor, variable glass 0.8 to 8.5 uuf, 1250V	106872	
C520	Capacitor, ceramic, 82 uuf ±2%, 600V	105940	
R505	Resistor, composition, 47Ω ±10%, 1/2W	108688	
R542	Resistor, variable wirewound, 2K ±10%, 1/4W	113191	
	Matched Resistor Set	*107995	
R504	Resistor, metal film, 1 Meg±1/2%, 1/2W		
R540	Resistor, metal film, 48.75K±1%, 1/2W		
R543	Resistor, metal film, 500K±1/2%, 1/2W		
	AC-Range-Switch Switch Assembly	*125047-4	
S2	Switch, range, AC section	*125120	

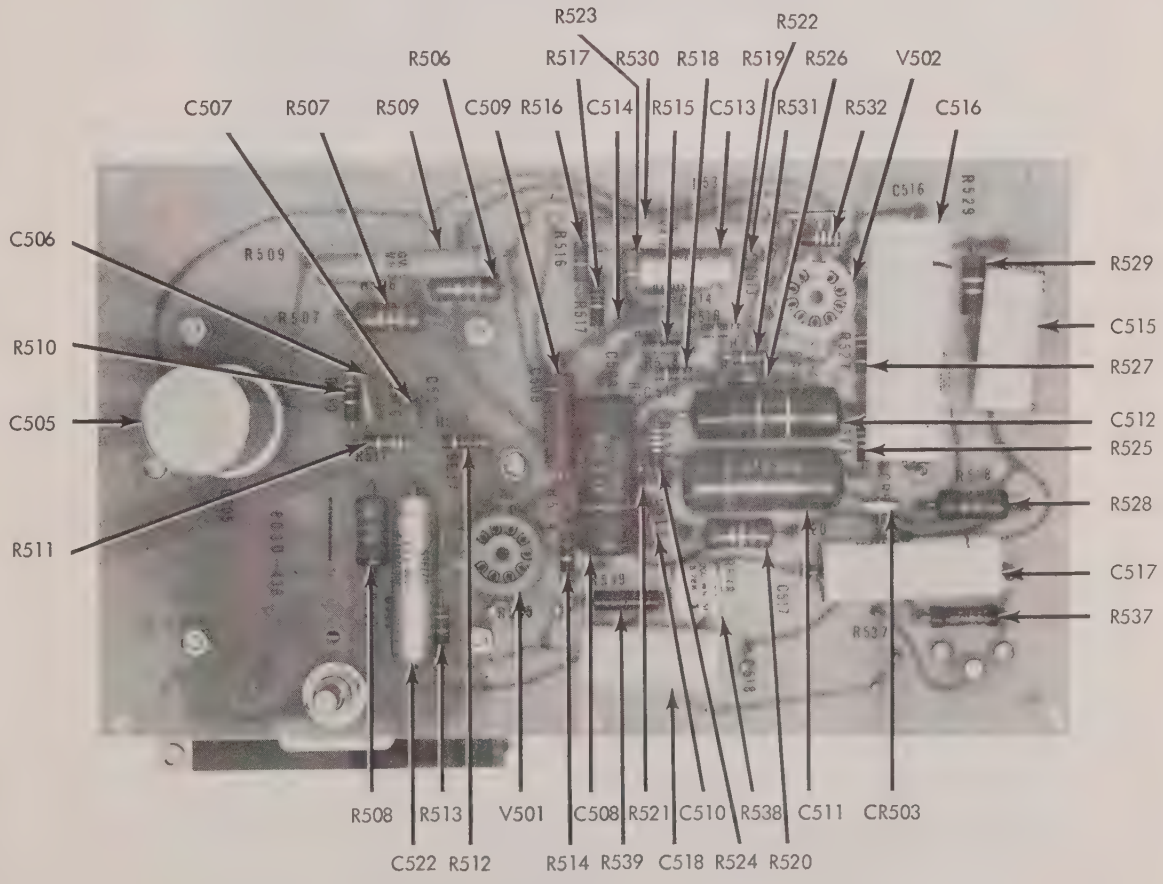


Figure 5-7. CONVERTER/AC RANGE SWITCH ASSEMBLY (Sheet 1 of 2)

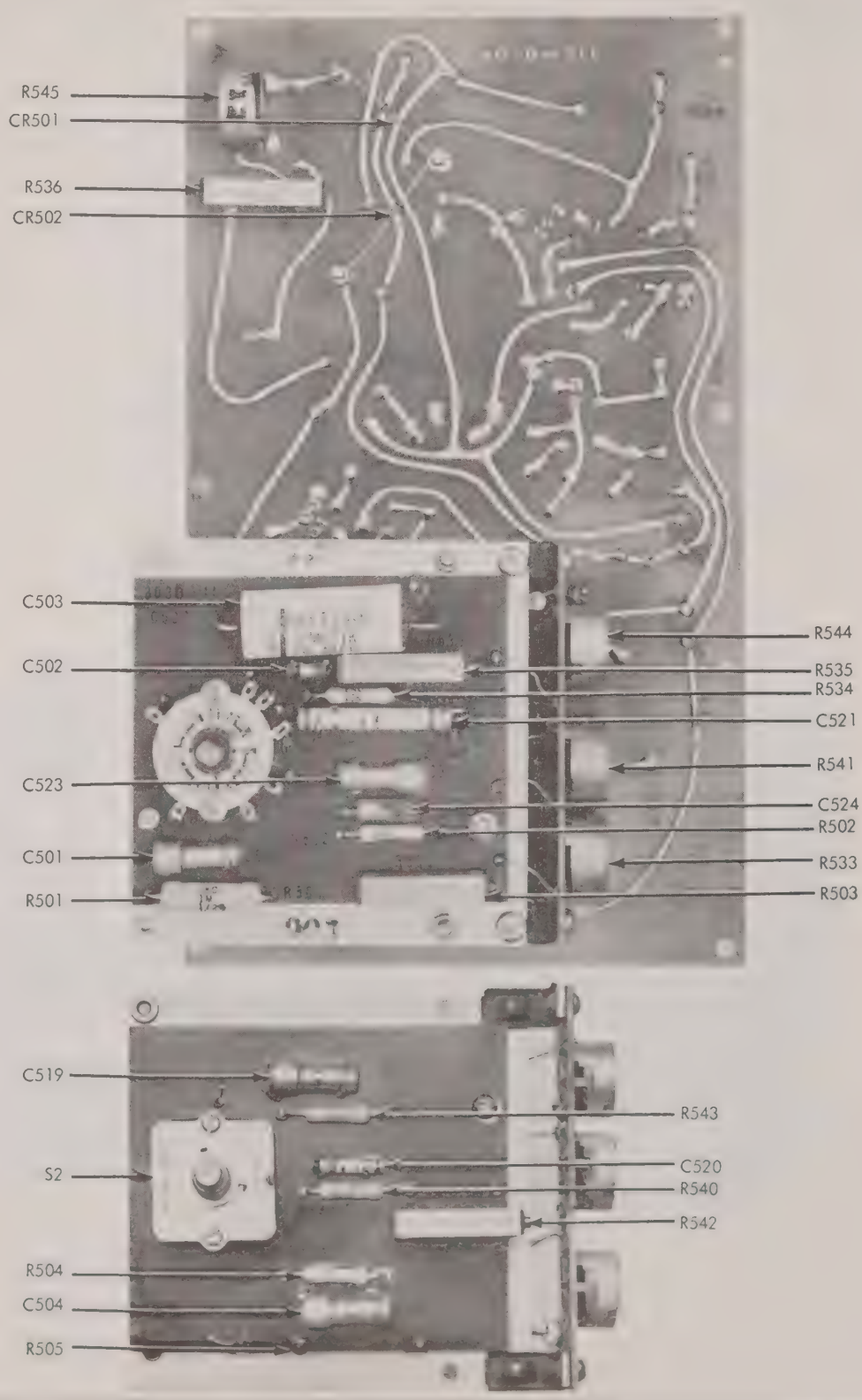


Figure 5-7. CONVERTER/AC RANGE SWITCH ASSEMBLY (Sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Chopper Drive Assembly	*125211	K
C701	Capacitor, plastic, 0.18 uf ±10%, 200V	105874	K
C702, C703	Capacitor, electrolytic, 20 uf -10/+100%, 50V	106229	K
C704	Capacitor, plastic, 0.18 uf ±10%, 200V	105874	K
Q701, Q702	Transistor, germanium, PNP, 2N1379	117143	K
Q703, Q704	Transistor, germanium, PNP, 2N1372	116129	K
R701	Resistor, deposited carbon, 44.2K ±1%, 1/2W	107912	K
R702	Resistor, composition, 120Ω ±10%, 1/2W	108696	K
R703	Resistor, deposited carbon, 44.2K ±1%, 1/2W	107912	K
R704, R705	Resistor, variable wirewound, 10K ±20%, 1-1/4W	112862	K
R706, R707	Resistor, composition, 820Ω ±10%, 1/2W	108423	K
R708, R709	Resistor, composition, 120Ω ±10%, 1W	109827	K

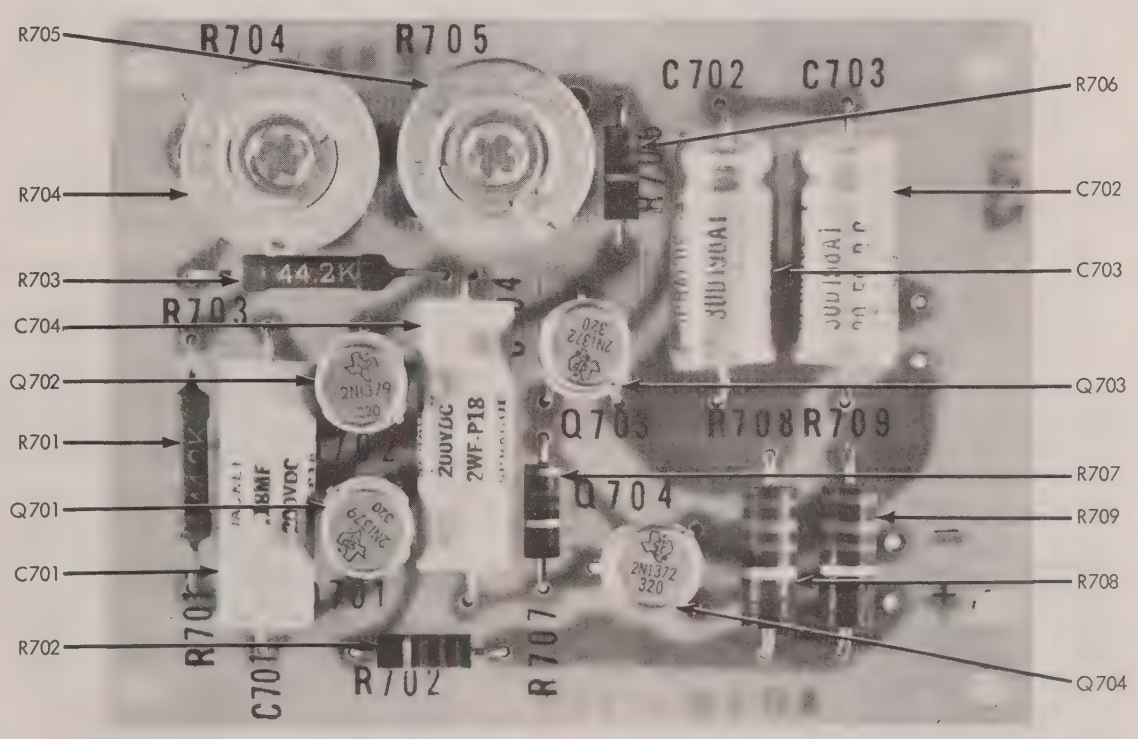


Figure 5-8. CHOPPER DRIVE ASSEMBLY

USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

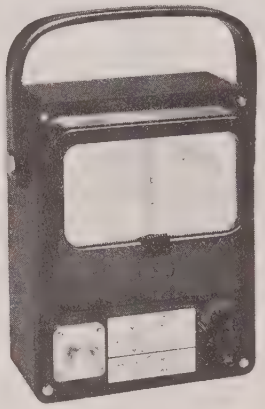
USE CODE	EFFECTIVITY
No Code	Model 823A serial number 123 and on Model 823AR serial number 123 and on Model 823A/AG serial number 123 and on Model 823AR/AG serial number 123 and on
A	Model 823A serial number 123 thru 174 Model 823AR serial number 123 thru 157 Model 823A/AG serial number 123 thru 174 Model 823AR/AG serial number 123 thru 157
B	Model 823A serial number 175 and on Model 823AR serial number 158 and on Model 823A/AG serial number 175 and on Model 823AR/AG serial number 158 and on
C	Model 823A serial number 123 thru 197 Model 823AR serial number 123 thru 157 Model 823A/AG serial number 123 thru 197 Model 823AR/AG serial number 123 thru 157
D	Model 823A serial number 198 and on Model 823AR serial number 158 and on Model 823A/AG serial number 198 and on Model 823AR/AG serial number 158 and on
E	Model 823A serial number 123 thru 237 Model 823AR serial number 123 thru 197 Model 823A/AG serial number 123 thru 237 Model 823AR/AG serial number 123 thru 197
F	Model 823A serial number 238 and on Model 823AR serial number 198 and on Model 823A/AG serial number 238 and on Model 823AR/AG serial number 198 and on
G	Model 823A serial number 123 thru 311 Model 823AR serial number 123 thru 231 Model 823A/AG serial number 123 thru 311 Model 823AR/AG serial number 123 thru 231
H	Model 823A serial number 312 and on Model 823AR serial number 232 and on Model 823A/AG serial number 312 and on Model 823AR/AG serial number 232 and on
I	Model 823A serial number 123 thru 442 Model 823AR serial number 123 thru 301 Model 823A/AG serial number 123 thru 442 Model 823AR/AG serial number 123 thru 301
J	Model 823A serial number 443 and on Model 823AR serial number 302 and on Model 823A/AG serial number 443 and on Model 823AR/AG serial number 302 and on
K	Model 823A serial number 123 thru 502 Model 823AR serial number 123 thru 326 Model 823A/AG serial number 123 thru 502 Model 823AR/AG serial number 123 thru 326
L	Model 823A serial number 503 and on Model 823AR serial number 327 and on Model 823A/AG serial number 503 and on Model 823AR/AG serial number 327 and on
M	Model 823A serial number 123 thru 502 Model 823AR serial number 123 thru 327 Model 823A/AG serial number 123 thru 502 Model 823AR/AG serial number 123 thru 327
N	Model 823A serial number 503 and on Model 823AR serial number 328 and on Model 823A/AG serial number 503 and on Model 823AR/AG serial number 328 and on
O	Model 823A serial number 123 thru 523 Model 823AR serial number 123 thru 357 Model 823A/AG serial number 123 thru 523 Model 823AR/AG serial number 123 thru 357
P	Model 823A serial number 524 and on Model 823AR serial number 358 and on Model 823A/AG serial number 524 and on Model 823AR/AG serial number 358 and on
Q	Model 823A serial number 123 thru 683 Model 823AR serial number 123 thru 654 Model 823A/AG serial number 123 thru 683 Model 823AR/AG serial number 123 thru 654
R	Model 823A serial number 684 and on Model 823AR serial number 655 and on Model 823 A/AG serial number 684 and on Model 823 AR/AG serial number 655 and on
S	Model 823A and 823A/AG serial number 503 thru 723 Model 823AR and 823AR/AG serial number 327 thru 684
T	Model 823A and 823A/AG serial number 724 and on Model 823AR and 823 AR/AG serial number 685 and on

SECTION VI

ACCESSORIES

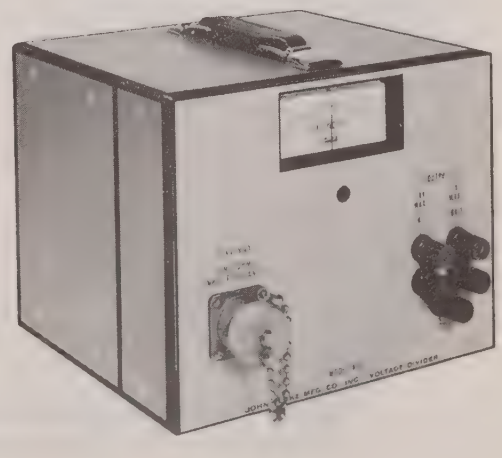
6-1. PRECISION VOLTAGE DIVIDERS

6-2. The FLUKE 80A, 80D, and 80E Voltage Dividers provide the FLUKE 800 Series Differential Voltmeters with the ability to make high accuracy measurements up to 30,000 volts DC. All models contain a zero center panel meter which allows the polarity and approximate magnitude of the unknown high voltage to be easily observed. At maximum input, all units draw but 1 ma of current from the unknown. The extreme accuracy and excellent long term stability of these dividers are obtained by using properly aged precision wirewound resistors which have a very low temperature coefficient. To further ensure high accuracy and long term stability at very high voltages, the 80D dividers have all resistance components immersed in oil within a hermetically sealed container. As an additional feature, all 80D and 80E models are provided with a 1 volt tap which allows measurements of high voltages with a laboratory potentiometer. Specifications for the standard models are shown on next page. Other intermediate models are available upon special request.



MODEL 80A

MODEL 80D



MODEL 80E

Model No.	Maximum Input Voltage	Total Resistance	Current Drawn At Max. Input	Division Ratio			Division Ratio Accuracy	Stability of Division Accuracy Per Year
				500V Out	10V Out	1V Out		
80A-1 80A-2	1 KV 2 KV	1 M 2 M	1 ma 1 ma	2:1 4:1	—— ——	—— ——	±0.015% ±0.015%	—— ——
80E-5 80E-10	5 KV 10 KV	5 M 10 M	1 ma 1 ma	— —	500:1 1000:1	5,000:1 10,000:1	±0.01% ±0.01%	±0.01% ±0.01%
80D-30	30 KV	30 M	1 ma	60:1	3000:1	30,000:1	±0.01%	±0.01%

MODELS	SIZE	INPUT CONNECTOR	OUTPUT CONNECTOR
80A	6-3/4" high 5-1/4" wide 2-1/4" deep	UG-560U with mating connector supplied	Insulated binding posts on 3/4" centers
80E	7" high 8-1/2" wide 8" deep	MS3102A-18-165 with mating connector supplied	Insulated binding posts on 3/4" centers for both outputs
80D	13" high 9-3/4" wide 16" deep	Special 5" ceramic standoff with mating 6" guard supplied	Insulated binding post on 3/4" centers for both outputs

MODEL A88 ISOLATION AMPLIFIER

6-3. ISOLATION AMPLIFIER

6-4. The FLUKE Model A88 all solid-state isolation amplifier is designed to provide isolation between the output of a differential voltmeter and the input of a recorder. Thus, the A88 will allow the use of a wide range of strip chart recorders for recording the voltmeter reading without regard to the input isolation characteristics of the recorder. The A88 is also excellent for making accurate dc microvolt and nanoampere measurements in the presents of common mode voltages up to 1100 vdc and 3 vac, 50 to 500 cycles.

GAIN: 1 volt output per microampere input.

GAIN ACCURACY: ±2%.

INPUT CURRENT RANGE: 0 to 2 microamperes.

INPUT VOLTAGE RANGE: 0 to 2 millivolts nominal.

INPUT RESISTANCE: 950 ohms (±5%).

OUTPUT VOLTAGE RANGE: 0 to 2 volts open circuit.

OUTPUT RESISTANCE: 1000 ohms (±5%).

INPUT ISOLATION FROM CHASSES: Greater than 5×10^{11} ohms at 25°C (77°F), 60% RH and 1×10^{10} ohms at 50°C (122°F), 60% RH.

ACCESSORY INFORMATION

MODEL 80F-5 VOLTAGE DIVIDER

6-1. INTRODUCTION

6-2. The Accessory Model 80F-5 Voltage Divider allows measurement of up to 5k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

6-3. Physical design of the Model 80F-5 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measure-

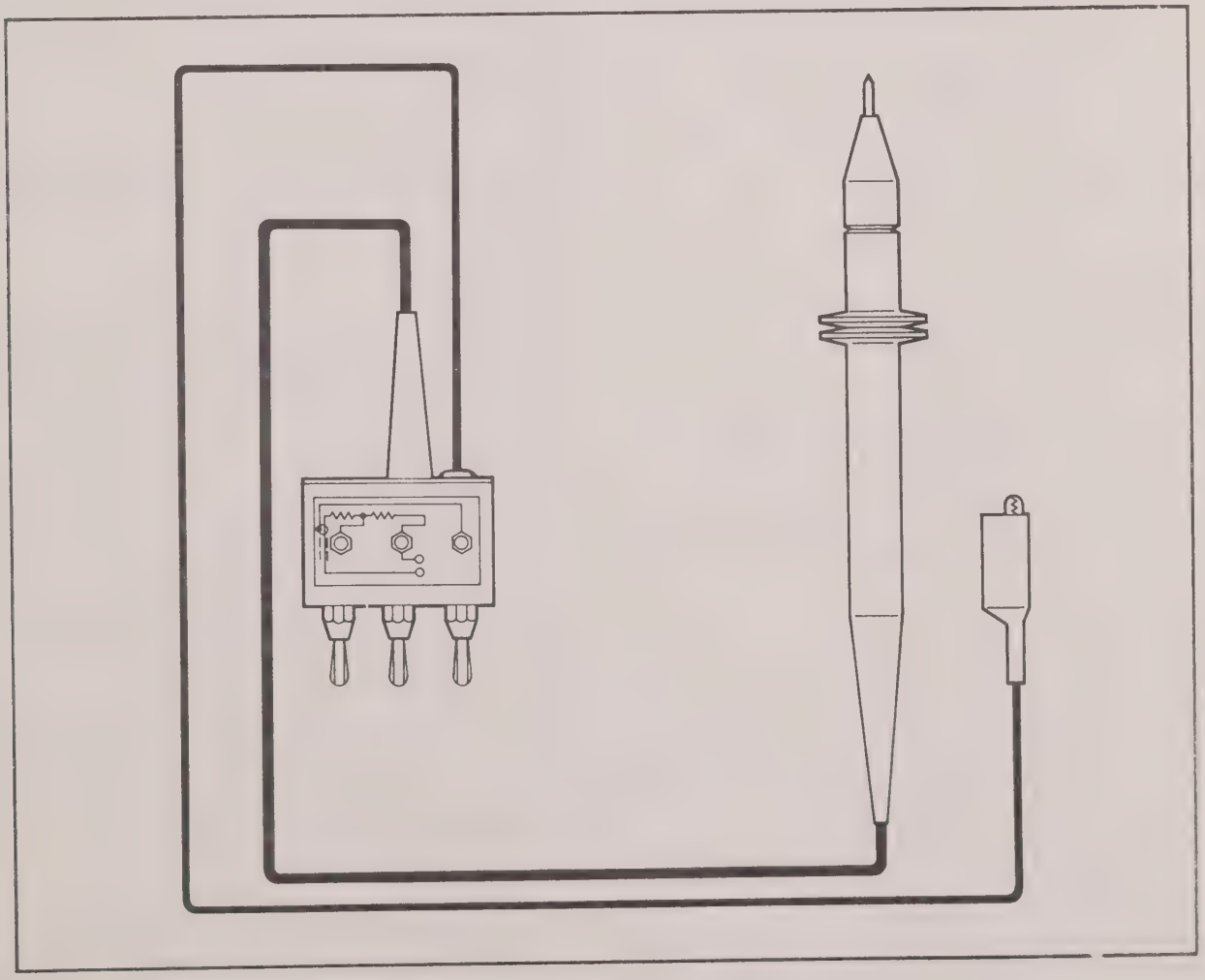


Figure 6-1. MODEL 80F-5 VOLTAGE DIVIDER

ment source. Maintenance is minimized by encapsulation of the divider components.

6-4. Three versions of the Model 80F-5 are available. The basic Model 80F-5 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohms or greater) at null.

6-5. SPECIFICATIONS

6-6. Electrical

DIVISION RATIO:
1000:1

RATIO ACCURACY:
±0.01% of input from 500 to 5000 vdc.

RATIO ACCURACY STABILITY:
±0.01% per month
±0.05% per year
} Calibrated by internal adjustment

VOLTAGE COEFFICIENT:
Less than 20 ppm total from 0 to 5000 vdc.

TEMPERATURE COEFFICIENT:
0.001%/°C

INPUT RESISTANCE:
50 Megohms

MAXIMUM INPUT VOLTAGE:
5000 vdc

REQUIRED VOLTMETER INPUT RESISTANCE:

80F-5	80F-5 (01)	80F-5 (02)
10 Megohms	11 Megohms	Infinite at null (10^3 megohms or greater)

MAXIMUM OUTPUT VOLTAGE:
5 vdc

6-7. Environmental

OPERATING:
Temperature Range – 0°C to 50°C
Humidity – 0 to 80%
Altitude Range – 0 to 10,000 feet

NON-OPERATING:
Altitude Range – 0 to 50,000 feet

6-8. Mechanical

DIMENSIONS
2.28 inches high x 1.52 inches wide x 1.525 inches deep.

WEIGHT:
20 ounces (340 grams)

6-9. OPERATING INSTRUCTIONS

a. Connect the Model 80F-5 output terminals directly to the INPUT terminals of the FLUKE voltmeter.

b. Select the appropriate dc voltage range on the FLUKE voltmeter.

c. Deenergize the high voltage source to be measured.

d. Connect the ground clip (–) and probe (+) to respective low and high sections of the high voltage source.

WARNING!

Lethal voltages will be present between the ground clip and probe of the 80F-5 when the high voltage source is energized.

e. Energize the high voltage source. Multiply the FLUKE voltmeter indication by 1000 to obtain the magnitude of the high voltage.

6-10. MAINTENANCE

6-11. General

6-12. The Model 80F-5 requires a minimum amount of maintenance. All that is required is occassional cleaning and calibration.

6-13. Cleaning

6-14. Accumulation of dust or dirt particles between the output terminals of the Model 80F-5 can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

6-15. Calibration

6-16. The Model 80F-5 division ratio should be checked every month or every year depending on the accuracy requirement. Ratio accuracy stability is specified at ±0.01% per month and ±0.05% per year. Calibration should be accomplished only after the Model 80F-5 has been in non-operating state for at least four hours at a temperature of 23°C.

6-17. Test equipment requirements are a stable 1000 volt dc source such as the FLUKE Model 332B Voltage Calibrator and the FLUKE voltmeter. To calibrate the Model 80F-5, perform the following steps:

NOTE

The input resistance of the voltmeter must match that of the 80F-5. See paragraph 6-6, REQUIRED VOLTMETER INPUT RESISTANCE.

a. Calibrate the FLUKE voltmeter.

b. Install the Model 80F-5 on the FLUKE voltmeter input terminals.

c. Unscrew the strain relief on the input cable of the Model 80F-5 and remove the front cover.

d. Select the appropriate dc voltage range on the FLUKE voltmeter.

e. Apply 1000 volts dc to the Model 80F-5 high voltage probe.

f. Adjust the variable resistor on the Model 80F-5 for a 1.0 volt dc indication on the FLUKE voltmeter.

g. Remove the voltage from the Model 80F-5 high voltage probe.

h. Install the Model 80F-5 front cover and strain relief.

ACCESSORY INFORMATION

MODEL 80F-15 VOLTAGE DIVIDER

6-1. INTRODUCTION

6-2. The Accessory Model 80F-15 Voltage Divider allows measurement of up to 15k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

6-3. Physical design of the Model 80F-15 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement

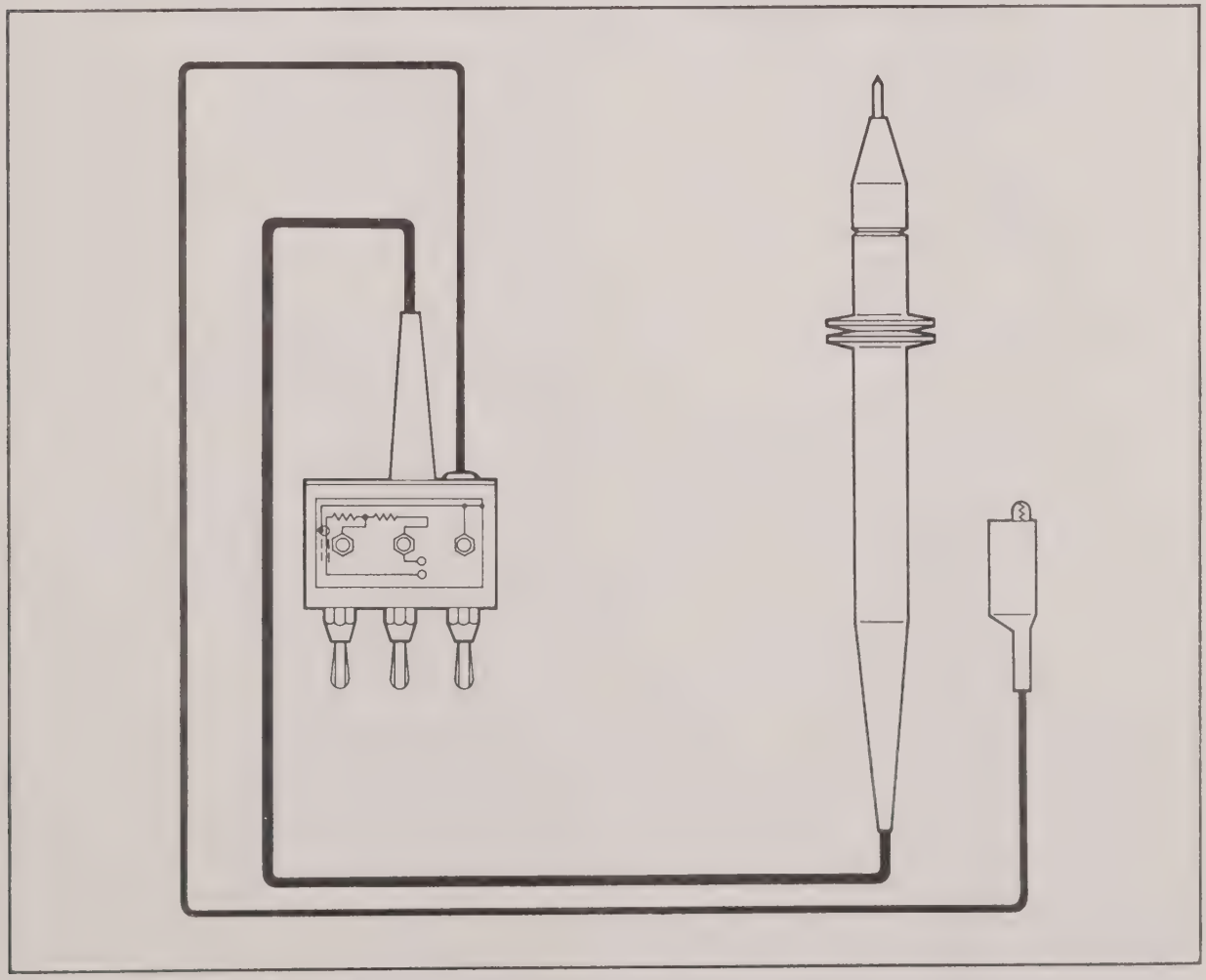


Figure 6-1. MODEL 80F-15 VOLTAGE DIVIDER

source. Maintenance is minimized by encapsulation of the divider components.

6-4. Three versions of the Model 80F-15 are available. The basic Model 80F-15 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohm or greater) at null.

6-5. SPECIFICATIONS

6-6. Electrical

DIVISION RATIO:
1000:1

RATIO ACCURACY:
±0.01% of input from 1,000 to 15,000 vdc.

RATIO ACCURACY STABILITY:
±0.01% per month
±0.05% per year } Calibrated by internal adjustment

VOLTAGE COEFFICIENT:
Less than 20 ppm total from 0 to 15,000 vdc.

TEMPERATURE COEFFICIENT:
0.001%/°C

INPUT RESISTANCE:
100 Megohms

MAXIMUM INPUT VOLTAGE:
15,000 vdc

REQUIRED VOLTMETER INPUT RESISTANCE:

80F-15	80F-15 (01)	80F-15 (02)
10 Megohms	11 Megohms	Infinite at null (10^3 megohms at greater)

MAXIMUM OUTPUT VOLTAGE:
15 vdc

6-7. Environmental

OPERATING:
Temperature Range – 0°C to 50°C
Humidity – 0 to 80%
Altitude Range – 0 to 10,000 feet

NON-OPERATING:
Altitude Range – 0 to 50,000 feet

6-8. Mechanical

WEIGHT:
24 ounces (680 grams)

DIMENSIONS:
2.725 inches high x 2.69 inches wide x 1.525 inches deep.

6-9. OPERATING INSTRUCTIONS

a. Connect the Model 80F-15 output terminals directly to the INPUT of the FLUKE voltmeter.

b. Select the appropriate dc voltage range on the FLUKE voltmeter.

c. Deenergize the high voltage source to be measured.

d. Connect the ground clip (–) and probe (+) to respective low and high sections of the high voltage source.

WARNING!

Lethal voltages will be present between the ground clip and probe of the 80F-15 when the high voltage source is energized.

e. Energize the high voltage source. Multiply the FLUKE voltmeter indication by 1000 to obtain the magnitude of the high voltage.

6-10. MAINTENANCE

6-11. General

6-12. The Model 80F-15 requires a minimum amount of maintenance. All that is required is occassional cleaning and calibration.

6-13. Cleaning

6-14. Accumulation of dust or dirt particles between the output terminals of the Model 80F-15 can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

6-15. Calibration

6-16. The Model 80F-15 division ratio should be checked every month or every year depending on the accuracy requirement. Ratio accuracy stability is specified at ±0.01% per month and ±0.05% per year. Calibration should be accomplished only after the Model 80F-15 has been in the non-operating state for at least four hours at a temperature of 23°C.

6-17. Test equipment requirements are a stable 1000 volt dc source such as the FLUKE Model 332B Voltage Calibrator and the FLUKE voltmeter. To calibrate the Model 80F-15, perform the following steps:

NOTE

The input resistance of the voltmeter must match that of the 80F-15. See paragraph 6-6, REQUIRED VOLTMETER INPUT RESISTANCE.

a. Calibrate the FLUKE voltmeter.

b. Install the Model 80F-15 on the FLUKE voltmeter input terminals.

c. Unscrew the strain relief on the input cable of the Model 80F-15 and remove the front cover.

d. Select the appropriate dc voltage range on the FLUKE voltmeter.

e. Apply 1000 volts dc to the Model 80F-15 high voltage probe.

f. Adjust the variable resistor on the Model 80F-15 for a 1.0 volt dc indication on the FLUKE voltmeter.

g. Remove the voltage from the Model 80F-15 high voltage probe.

h. Install the Model 80F-15 front cover and strain relief.

ACCESSORY INFORMATION

MODEL 80-RF HIGH FREQUENCY PROBE

6-1. INTRODUCTION

62. The Model 80-RF High Frequency Probe allows measurements over a frequency range of 100 kHz to 500 MHz from 0.25 to 30 volts when using FLUKE voltmeters having an input impedance of 10 megohms ±10%. The accuracy of measurement is ±5% from 100 kHz to 100 MHz and +7% to 500 MHz. The probe operates into any dc voltmeter having an input impedance of 10 megohms ±10%. A shielded dual-banana plug on the probe permits direct connection to the voltmeter input.

6-3. SPECIFICATIONS

6-4. Electrical

VOLTAGE 0.25V to 30V

RESPONSE: Responds to peak value of input. Calibrated to read rms value of a sine wave input.

AC TO DC TRANSFER ACCURACY:
Loaded with 10 megohms ±10%.

	100 KHz – 100 MHz	100 MHz – 500 MHz
+10°C to +30°C	±5%	±7%
−10°C to +40°C	±7%	±15%

<±3 db at 10 kHz and 700 MHz.

INPUT IMPEDANCE: 4 megohms shunted by 2 ±0.5 pf.

MAXIMUM INPUT: 30 volts rms AC, 200 volts DC.

6-5. General

CABLE CONNECTIONS: Shielded dual banana plug
Fits all standard 3/4-inch dual banana connectors.

CABLE LENGTH: 4 ft(121.9 cm) minimum.

WEIGHT: 3-½ oz. net.

ACCESSORIES SUPPLIED
Ground Lead
Straight Tip
Hook Tip
High Frequency Adapter

6-6. OPERATING INSTRUCTIONS

6-7. Connect the shielded dual banana plug directly to the voltmeter input terminals, GND to COMMON or LO. Affix the appropriate probe tip to the probe body, then connect the probe to the high frequency circuit under test. When using the Straight or Hook Tip the ground clip must be connected to the test circuit. When using the high frequency adaptor with appropriate 50 ohm connectors, the ground clip is not required.

6-8. The Straight Tip or Hook Tip supplied with the probe can be used for measurements up to 100 MHz. For measurements above 100 MHz the High Frequency Adapter allows connections to 50 ohm terminations. Ensure that the probe is used in conjunction with dc voltmeters having 10 MΩ ±10% input impedance to meet its specifications.

6-9. The maximum input to the probe is 30 volts rms ac, or 200 volts dc. These factors may be used in combination so that an ac signal may be measured riding on a dc voltage of up to 200 volts. However, it must be noted that if ac superimposed on dc is being measured, the dc level must not be changed by more than 200 volts or the resulting transient is apt to damage the diodes inside the probe.

6-10. THEORY OF OPERATION

6-11. Figure 6-1 contains a schematic diagram of the probe. C1 is a dc blocking capacitor, CR1 is used as a detector, and R1, R3, CR2, R2, and Rin form a divider network. C1, charging through CR1 during the negative half cycle of the input produces a positive dc voltage at the CR1-R1 junction which equals the negative peak value of the input signal. The divider network reduces this to the rms value of the input. It can be seen that the probe must be operated into a 10 MΩ load in order to maintain the proper division ratio.

6-12. CR2 provides compensation for the non-linearity of the detector. R3 is a selected part having a value of 50 kΩ to 100 kΩ, as required for proper divider action.

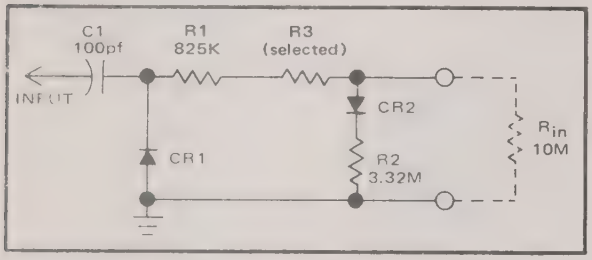


Figure 6-1. SCHEMATIC

6-13. MAINTENANCE

6-14. Performance Checks

6-15. The following checks verify the probe AC to DC Transfer accuracy.

6-16. LOW FREQUENCY RESPONSE. Connect equipment as shown in Figure 6-2, and perform the following steps.

a. With equipment as shown in connection "A" adjust the ac signal source for an output of 3.000 volts rms at 100 kHz as measured on the DVM.

b. In connection "B" with the DVM set to measure dc, observe a probe output of 3.15 to 2.85 volts.

c. Placing cables back in connection "A", decrease the ac signal source by 10db (0.95 volts).

d. Moving back to connection "B", observe a voltmeter indication of between 1.00 and 0.90 volts (10 db down from 3 volts).

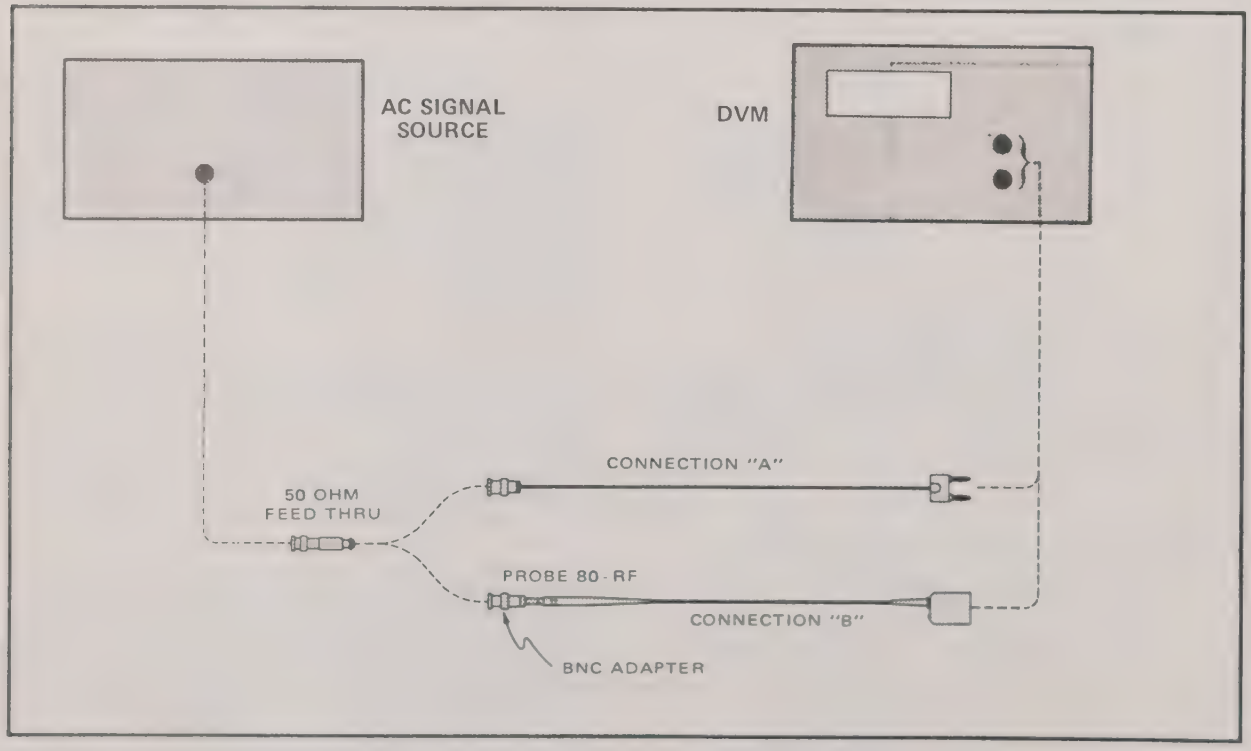


Figure 6-2. LOW FREQUENCY RESPONSE CHECK

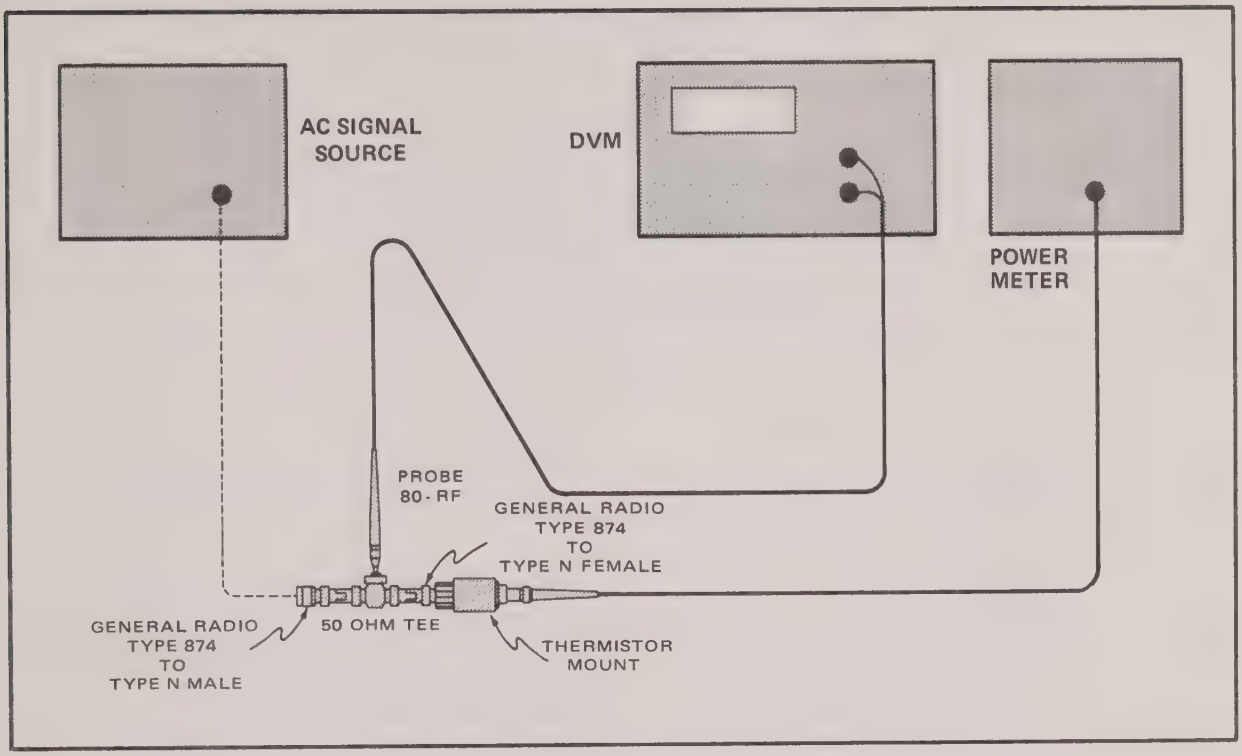


Figure 6-3. HIGH FREQUENCY RESPONSE CHECK

e. In connection "A", decrease the ac signal source an additional 10 db (to 0.3 volts) as indicated by the voltmeter in its ac function.

f. Back to "B", observe a voltmeter reading of .315 to .285 vdc.

g. Return the ac signal source back to 3.000 vrms.

h. Repeat steps a through g with frequencies of 500 kHz, 1 MHz, and 10 MHz.

6-17. HIGH FREQUENCY RESPONSE. Connect equipment to the 80-RF probe as shown in Figure 6-3, and perform the following steps:

a. Set the ac signal source ot 100 MHz with an output level of 10 milliwatts as indicated on the power meter. Ensure that the ac signal source has stabilized at 10 millivolts output.

b. Observe that the voltmeter indication is between 0.757 and 0.657 volts. (0.707 volts corresponds to 10 milliwatts in 50 ohms).

c. Repeat the above for frequencies of 200 MHz, 300 MHz, 400 MHz, and 480 MHz.

6-18. Calibration

6-19. Should the 80-RF require recalibration, perform the following steps:

a. Perform steps a and b in paragraph 6-16, with a frequency of 1 MHz.

b. Observe the dc voltmeter indication; a reading below 3 volts calls for a decrease in the value of R3, a reading above 3 volts calls for an increase in R3. Resistor R3 should be a 1/8 W metal film type. In a probe that is working properly, a 30 kΩ change in R3 will produce about a 1% reading deviation.

6-20. Cleaning

6-21. The Model 80-RF requires a minimum amount of cleaning. Accumulation of dust or dirt particles between the output terminals of the Model 80-RF can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

ACCESSORY INFORMATION

MODEL A90 CURRENT SHUNT

6-1. INTRODUCTION

6-2. The Model A90 Current Shunt is designed for use with any high-impedance ac or dc voltmeter capable of accurately measuring 100 millivolts. Six Fluke precision wire wound and strip resistors provide a 100 millivolt full-scale output for each of six pushbutton current ranges: 0.1, 1, 10, 100, and 1000 milliamperes and 10 amperes (ac or dc). Basic accuracy is specified over a frequency range of dc to 4 kHz for the 10 ampere range and dc to 10 kHz for the milliampere ranges.

6-3. The instrument is supplied in half-rack case so that it may be conveniently mounted side-by-side with other half-rack instruments in a standard 19-inch rack. A carrying handle detents into custom non-marring feet and serves as a tilt-up bail for bench use.

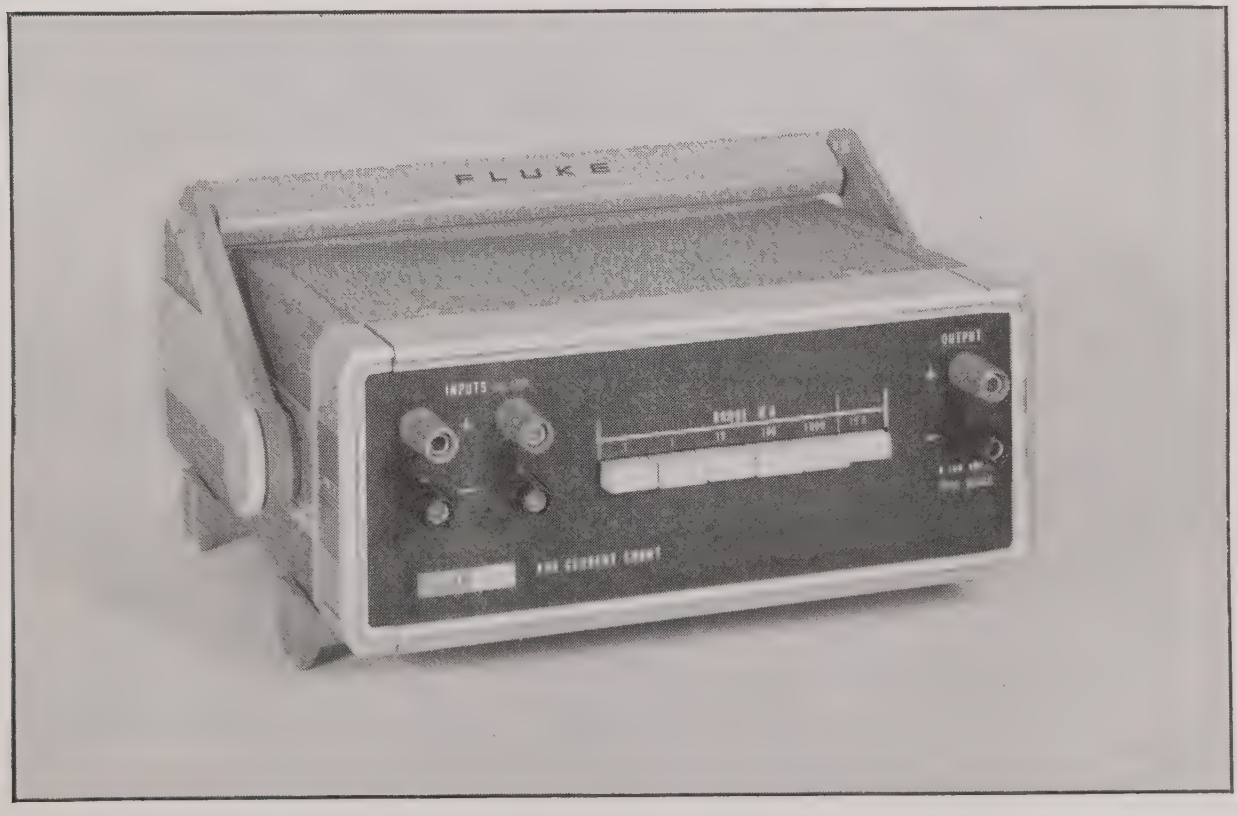
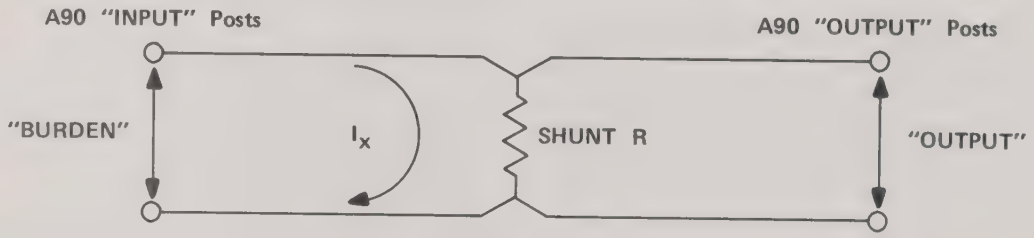


Figure 6-1. MODEL A90 CURRENT SHUNT

Table 6-1. ACCURACY OF A90 (1 year, 15°C - 35°C)

RATED CURRENT RANGE	E BURDEN (APPROX.)	SHUNT R	"OUTPUT" AT RATED CURRENT	"OUTPUT" ACCURACY AS % OF CURRENT INPUT	
				DC ONLY	DC TO 10 KHZ AC
0.1 ma	100 mv	1 kΩ	100 mv	±0.1%	±0.1%
* 0.1 ma	100 mv	1 kΩ	100 mv	+0.0% −0.2%	+0.0% −0.2%
1.0 ma	100 mv	100Ω	100 mv	±0.1%	±0.1%
10 ma	100 mv	10Ω	100 mv	±0.1%	±0.1%
100 ma	102 mv	1Ω	100 mv	±0.1%	±0.1%
1A	120 mv	0.1Ω	100 mv	±0.1%	±0.2%
10A	300 mv	0.01Ω	100 mv	±0.2%	±0.3% (to 4 kHz)

* With 1 MΩ Input R Voltmeter.
When Input R is ⩾10 MΩ, use non-asterisked 0.1 ma specification.



Simplified diagram illustrating terms used in table.

6-4. SPECIFICATIONS

6-5. Electrical

RANGE
0.1, 1, 10, 100, and 1000 milliamps and 10 amperes.

ACCURACY
Table 6-1 gives accuracy specifications for the Model A90 only. Total current measurement accuracy is also dependent on the accuracy and input impedance of the voltmeter being used.

SENSITIVITY
100 millivolts full scale.

OVERLOAD
Model A90 will not be damaged by 100% overload on each range below 10 amperes or by 50% overload on the 10 ampere range.

6-6. Mechanical

CURRENT SELECTION
Pushbutton, each range.

CONNECTORS
Positive (+) and negative (–) INPUT and OUTPUT binding posts with separate input posts for 10 ampere range.

DIMENSIONS
The Model A90 outline drawing is shown in Figure 6-2.

RACK MOUNTING KITS (OPTIONAL)
MEE-7014: Side-by-side Half-rack Mounting Kit
MEE-7006: Center Rack Mounting Kit
MEE-7013: Left or right of center Mounting Kit.

6-7. AUXILIARY ELECTRICAL SPECIFICATIONS

6-8. Tables 6-2 through 6-6 provide accuracy specifications for the Model A90 when used with Fluke Models

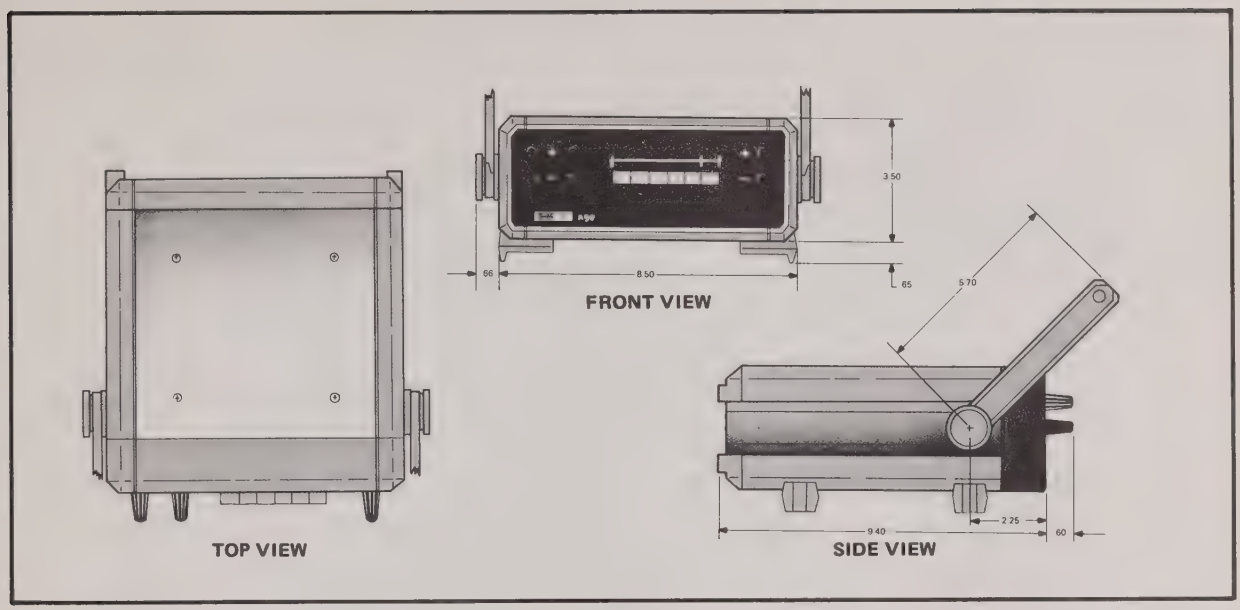


Figure 6-2. MODEL A90 OUTLINE DRAWING

Table 6-2. A90/8100A ACCURACY. 30 days, @ 23°C ±5°C.

DC ACCURACY	
CURRENT RANGE	SPECIFICATION
0.1 ma	±(0.12% of current input + 0.1 ua)
1.0 ma	±(0.12% of current input + 1.0 ua)
10 ma	±(0.12% of current input + 10 ua)
100 ma	±(0.12% of current input + 0.1 ma)
1A	±(0.12% of current input + 1.0 ma)
10A	±(0.22% of current input + 10 ma)

AC ACCURACY		
CURRENT RANGE	30 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.5% of current input + 1.0 ua) –(0.7% of current input + 1.0 ua)	+(0.2% of current input + 0.5 ua) –(0.4% of current input + 0.5 ua)
1.0 ma	±(0.6% of current input + 10 ua)	±(0.3% of current input + 5.0 ua)
10 ma	±(0.6% of current input + 0.1 ma)	±(0.3% of current input + 50 ua)
100 ma	±(0.6% of current input + 1.0 ma)	±(0.3% of current input + 0.5 ma)
1A	±(0.7% of current input + 10 ma)	±(0.4% of current input + 5.0 ma)
10A	±(0.8% of current input + 100 ma)	±(0.5% of current input + 50 ma)*
*10A specified to 4 kHz only.		

For:	DC CURRENT	AC CURRENT
	V_r = 1v	V_r = 1v
	V_{dfs} = ±.1000	V_{dfs} = .1000

Table 6-3. A90/8300A ACCURACY

DC CURRENT ACCURACY

MEASUREMENTS WITHOUT MV/OHMS OPTION INSTALLED

CURRENT RANGE	24 hr @ 23°C ±1°C	90 days @ 23°C ±5°C
0.1 ma	±(0.1% of current input + 0.1 ua)	±(0.11% of current input + 0.3 ua)
1.0 ma	±(0.1% of current input + 1.0 ua)	±(0.11% of current input + 3.0 ua)
10 ma	±(0.1% of current input + 10 ua)	±(0.11% of current input + 30 ua)
100 ma	±(0.1% of current input + 0.1 ma)	±(0.11% of current input + 0.3 ma)
1A	±(0.1% of current input + 1.0 ma)	±(0.11% of current input + 3.0 ma)
10A	±(0.2% of current input + 10 ma)	±(0.21% of current input + 30 ma)

V_r = 10 VDC

V_{dfs} = 0.1000 (Readout also will display "DC +" or "DC –").

MEASUREMENTS WITH MV/OHMS OPTION (8300A-02) INSTALLED

CURRENT RANGE	90 days @ 23°C ±5°C
0.1 ma	±(0.11% of current input + 0.01 ua)
1.0 ma	±(0.11% of current input + 0.1 ua)
10 ma	±(0.11% of current input + 1.0 ua)
100 ma	±(0.11% of current input + 10 ua)
1A	±(0.11% of current input + 0.1 ma)
10A	±(0.21% of current input + 1.0 ma)

V_r = 100 MV (0.1v)

V_{dfs} = 100.000 (Readout will also display MV DC + or MV DC–)

AC CURRENT ACCURACY

MEASUREMENTS WITH AC OPTION 8300A-01 INSTALLED

90 days @ 23°C ±5°C using AC Zero control periodically.

CURRENT RANGE	30 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.5% of current input + 0.05 ua) –(0.7% of current input + 0.05 ua)	+(0.1% of current input + 0.05 ua) –(0.3% of current input + 0.05 ua)
1.0 ma	±(0.6% of current input + 0.5 ua)	±(0.2% of current input + 0.5 ua)
10 ma	±(0.6% of current input + 5.0 ua)	±(0.2% of current input + 5.0 ua)
100 ma	±(0.6% of current input + 50 ua)	±(0.2% of current input + 50 ua)
1A	±(0.7% of current input + 0.5 ma)	±(0.3% of current input + 0.5 ma)
10A	±(0.8% of current input + 5.0 ma)	±(0.4% of current input + 5.0 ma)*

V_r = 1 VAC

V_{dfs} = .10000 (Readout will also display "AC")

*10A specified to 4 kHz only.

Table 6-4. A90/9500A SPECIFICATIONS

ACCURACY WHEN UNKNOWN CURRENT IS 20% OR MORE OF A90 CURRENT RANGE. (23°C ±1°C)

CURRENT RANGE	20 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.3% of current input + 0.02 ua) –(0.5% of current input + 0.02 ua)	+(0.05% of current input + 0.015 ua) –(0.25% of current input + 0.015 ua)
1.0 ma	±(0.4% of current input + 0.2 ua)	±(0.15% of current input + 0.15 ua)
10 ma	±(0.4% of current input + 2.0 ua)	±(0.15% of current input + 1.5 ua)
100 ma	±(0.4% of current input + 20 ua)	±(0.15% of current input + 15 ua)
1A	±(0.5% of current input + 0.2 ma)	±(0.25% of current input + 0.15 ma)
10A	±(0.6% of current input + 2.0 ma)	±(0.35% of current input + 1.5 ma)*

ACCURACY WHEN UNKNOWN CURRENT IS BETWEEN 10% AND 20% OF A90 CURRENT RANGE.

A90 INPUT (% OF CURRENT RANGE)	% OF INPUT ABSOLUTE ACCURACY 20 Hz – 50 Hz @ 23°C ±1°C FOR A90 CURRENT RANGE				
	0.1 ma				
	+	–	1 ma – 100 ma	1A	10A
10-11%	0.53%	0.73%	± 0.63%	±0.73%	±0.83%
12-14%	0.50%	0.70%	± 0.60%	±0.70%	±0.80%
15-17%	0.47%	0.67%	± 0.57%	±0.67%	±0.77%
18-20%	0.44%	0.64%	± 0.54%	±0.64%	±0.74%

A90 INPUT (% OF CURRENT RANGE)	% OF INPUT ABSOLUTE ACCURACY 50 Hz – 10 kHz @23°C ±1°C FOR A90 CURRENT RANGE				
	0.1 ma				
	+	–	1 ma – 100 ma	1A	10A*
10-11%	0.23%	0.43%	±0.33%	±0.43%	±0.53%
12-14%	0.20%	0.40%	±0.30%	±0.40%	±0.50%
15-17%	0.17%	0.37%	±0.27%	±0.37%	±0.47%
18-20%	0.13%	0.33%	±0.23%	±0.33%	±0.43%

V_r = .1v

V_{dfs} = .10000

TC = 0.005% of current input/°C 20 Hz –50 Hz
0.004% of current input/°C 50 Hz – 10 kHz

*10A is specified to 4 kHz only.

8100A, 8300A, 9500A, 891A, 893A, and 931B. Table 6-7 gives V_r and V_{dfs} for each of the voltmeters listed in the tables in addition to various other Fluke voltmeters, where

V_r = Voltage range to be used on the voltmeter
and V_{dfs} = Nominal voltmeter reading with full-scale current in A90 shunt.

6-9. INSTALLATION

6-10. There are three rack-mount kits available, at additional cost, for use with the Model A90. Kit MEE-7014 allows the Model A90 to be mounted side-by-side with another half-rack instrument in a standard 19-inch rack. Kit MEE-7006 supplies hardware necessary to mount the

Table 6-5. A90/891A AND 893A ACCURACY (Sheet 1 of 2)

WITH 891A AND 893A – DC ACCURACY		
CURRENT RANGE	@ 23°C ±2°C	@ 15°C –35°C
0.1 ma	±(0.11% of current input + 0.02 ua)	±(0.12% of current input + 0.02 ua)
1.0 ma	±(0.11% of current input + 0.2 ua)	±(0.12% of current input + 0.2 ua)
10 ma	±(0.11% of current input + 2.0 ua)	±(0.12% of current input + 2.0 ua)
100 ma	±(0.11% of current input + 20 ua)	±(0.12% of current input + 20 ua)
1A	±(0.11% of current input + 0.2 ma)	±(0.12% of current input + 0.2 ma)
10A	±(0.21% of current input + 2.0 ma)	±(0.22% of current input + 2.0 ma)
V_r = 1v V_{dfs} = 0.10000		

WITH 893A – AC ACCURACY @ 23°C ±2°C	
CURRENT RANGE	50 Hz – 10 kHz
0.1 ma	+(0.05% of current input + 0.025 ua) –(0.25% of current input + 0.025 ua)
1.0 ma	±(0.15% of current input + 0.25 ua)
10 ma	±(0.15% of current input + 2.5 ua)
100 ma	±(0.15% of current input + 25 ua)
1A	±(0.25% of current input + 0.25 ma)
10A	±(0.35% of current input + 2.5 ma)*

WITH 893A – AC ACCURACY @ 15°C –35°C		
CURRENT RANGE	5 Hz – 10 Hz	10 Hz – 20 Hz
0.1 ma	+(1.0% of current input + 0.25 ua) –(1.2% of current input + 0.25 ua)	+(0.5% of current input + 0.1 ua) –(0.7% of current input + 0.1 ua)
1.0 ma	±(1.1% of current input + 2.5 ua)	±(0.6% of current input + 1.0 ua)
10 ma	±(1.1% of current input + 25 ua)	±(0.6% of current input + 10 ua)
100 ma	±(1.1% of current input + 0.25 ua)	+(0.6% of current input + 0.1 ma)
1A	±(1.2% of current input + 2.5 ma)	±(0.7% of current input + 1.0 ma)
10A	±(1.3% of current input + 25 ma)	±(0.8% of current input + 10 ma)

893A – AC ACCURACY @ 15°C –35°C.		
CURRENT RANGE	20 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.15% of current input + 0.025 ua) –(0.35% of current input + 0.025 ua)	+(0.1% of current input + 0.025 ua) –(0.3% of current input + 0.025 ua)
1.0 ma	±(0.25% of current input + 0.25 ua)	±(0.2% of current input + 0.25 ua)
10 ma	±(0.25% of current input + 2.5 ua)	±(0.2% of current input + 2.5 ua)
100 ma	±(0.25% of current input + 25 ua)	±(0.2% of current input + 25 ua)
1A	±(0.35% of current input + 0.25 ma)	±(0.3% of current input + 0.25 ma)
10A	±(0.45% of current input + 2.5 ma)	±(0.4% of current input + 2.5 ma)*

Table 6-5. A90/891A AND 893A ACCURACY (Sheet 2 of 2)

V_r = 1v (AC or DC) V_{dfs} = 0.10000 *10A is specified to 4 kHz only.

Table 6-6. A90/931B SPECIFICATIONS

ACCURACY WHEN UNKNOWN CURRENT IS 10% OR MORE OF A90 CURRENT RANGE				
CURRENT RANGE	% OF INPUT ABSOLUTE ACCURACY 2 Hz – 3 Hz	3 Hz – 5 Hz	5 Hz – 30 Hz	SPECIFICATIONS 30 Hz – 10 kHz
0.1 ma	+1.0% –1.2%	+0.5% –0.7%	+0.2% –0.4%	+(0.05% of current input + 5 na) –(0.25% of current input + 5 na)
1.0 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 50 na)
10 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 0.5 ua)
100 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 5 ua)
1A	±1.2%	±0.7%	±0.4%	±(0.25% of current input + 50 ua)
10A	±1.3%	±0.8%	±0.5%	±(0.35% of current input + 0.5 ma)*
TC=	±0.1%/°C	±0.05%/°C	±0.025%/°C	±0.0025%/°C

V_r = 100 MV
V_{dfs} = 100.000

*10A is specified to 4 kHz only.

Table 6-7. "V_r" AND "V_{dfs}" FOR VOLTMETERS OF TABLES 6-2 THROUGH 6-6

VOLTMETER	"V_r"	"V_{dfs}"
8300A (Without MV/Ohms)	10v	.010
8100A, 871A, 873A, 881A, 883A, 885A, 887A, 891A, 893A	1v	.100
801, 803, 801B, 803B, 803D, 821A, 823A, 825A	0.5v	.100
9500A, 910A	0.1v	.100
8300A (With MV/Ohms), 931A, 931B	100 MV	100.0

V_r = Voltage range to be used on the voltmeter.
V_{dfs} = Nominal voltmeter reading with full-scale current in A90 shunt.

instrument in the center of the rack. Kit MEE-7013 supplies two different sized rack ears so that the instrument can be mounted to the left or to the right of rack center.

6-11. OPERATING INSTRUCTIONS

6-12. A description of Model A90 controls and terminals is given in Figure 6-3.

6-13. Equipment Connections

6-14. It is recommended that the Model A90 always be used in the "LO" lead as shown in Figure 6-4A. When used in the "HI" lead, as shown in Figure 6-4B, the distributed capacitance, C_{DIST}, loads the source. When connected in the "HI" lead, the voltmeter guard should either be connected as shown or else the voltmeter should be battery operated.

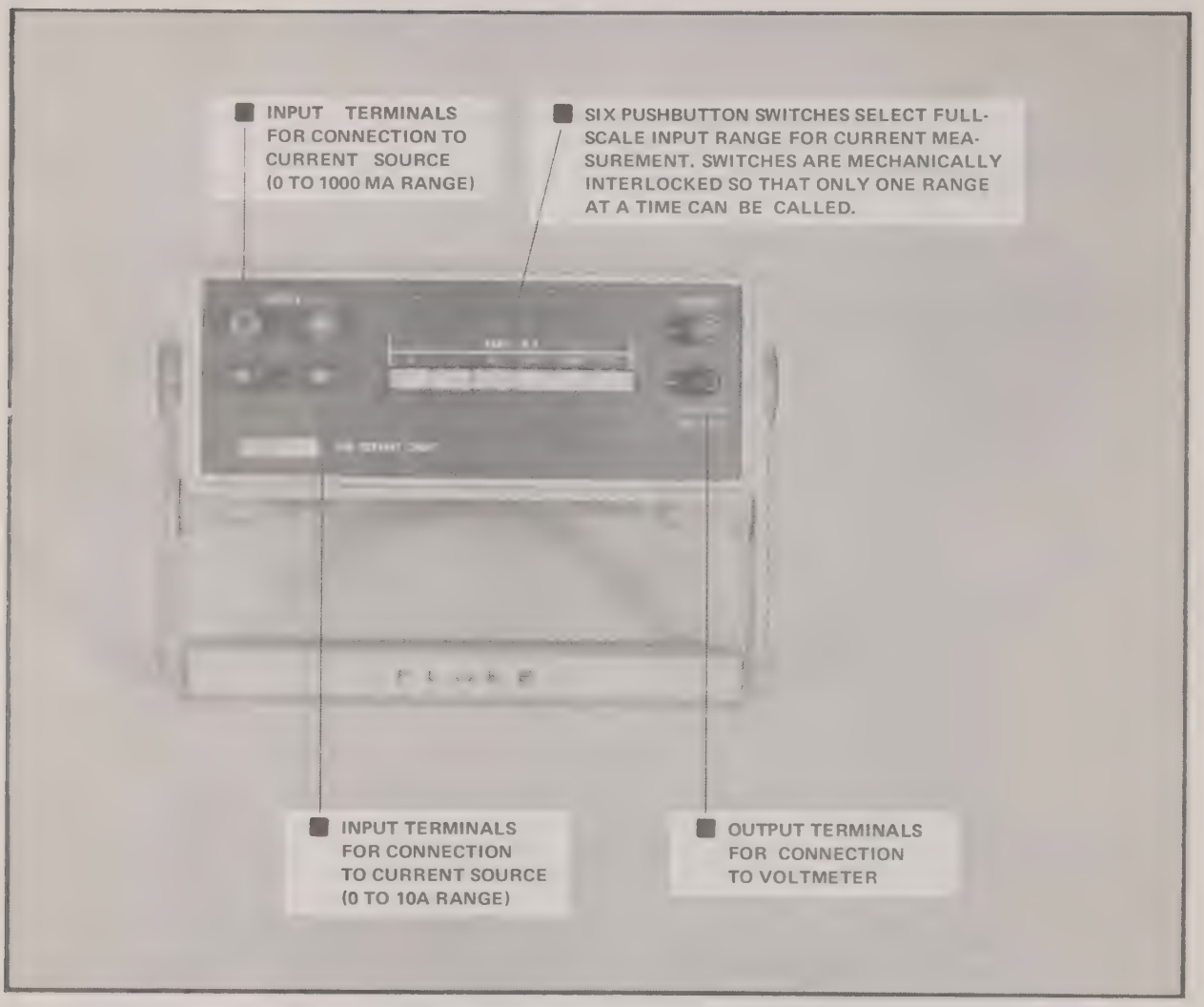

INPUT TERMINALS FOR CONNECTION TO CURRENT SOURCE (0 TO 1000 MA RANGE)
SIX PUSHBUTTON SWITCHES SELECT FULL-SCALE INPUT RANGE FOR CURRENT MEASUREMENT. SWITCHES ARE MECHANICALLY INTERLOCKED SO THAT ONLY ONE RANGE AT A TIME CAN BE CALLED.
INPUT TERMINALS FOR CONNECTION TO CURRENT SOURCE (0 TO 10A RANGE)
OUTPUT TERMINALS FOR CONNECTION TO VOLTMETER

Figure 6-3. MODEL A90 CONTROLS AND TERMINALS.

6-15. At high ac currents, performance of the A90 may depend upon the manner in which the current leads are connected to the input binding posts. Optimum performance is obtained when the input current leads are twisted.

6-16. Voltmeter Impedance

6-17. The input impedance of the voltmeter which is used with the Model A90 is significant with regard to total measurement accuracy. As indicated in the specifications, Model A90 measurement accuracy is derated for voltmeters having finite input impedance. As the voltmeter input capacity increases, the Model A90 response rolls off at the high end; and as the voltmeter input resistance decreases, the response shifts downward, resulting in negative measurement errors.

6-18. Combining Model A90 And Voltmeter Specifications

6-19. Combined specifications for the A90 when used with various Fluke voltmeters is given in Tables 6-2 through 6-6. When the A90 is used with other voltmeters, the following information may be used to combine specifications.

6-20. Equation 1 (Figure 6-5) is used to combine A90 and voltmeter specifications for overall accuracy. The "W" term is taken from Table 6-1, and the "X", "Y" and "Z" terms are taken from voltmeter specifications (data sheets). All Fluke voltmeter specifications, except the Model 910A, contain the "X" term; they usually list the "Y" term and occasionally the "Z" term. Model 910A accuracy specifi-

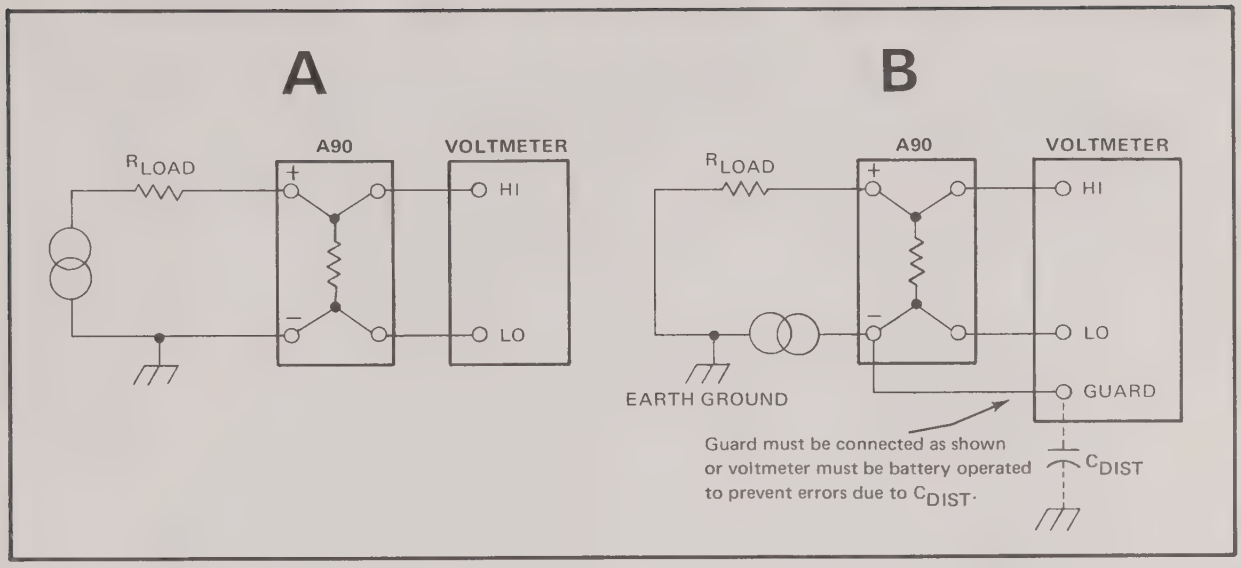


Figure 6-4. EQUIPMENT CONNECTIONS FOR CURRENT MEASUREMENT.

EQUATION 1. COMBINING A-90 SPECIFICATION WITH VOLTMETER SPECIFICATION.

A-90 Specification (from Table 6-1) | Voltmeter Specification (from Voltmeter Data Sheet)

$$\pm\ W\ \% \qquad \pm\ (\ X\ \%\ \text{of input} + Y\ \%\ \text{of range} + Z\ \text{uv}\ )$$

Vr = Lowest voltmeter range that will measure 100 MV

$$= \pm\ \left[\ (\ W + X\ )\ \%\ \text{of current input} + \frac{Vr}{0.1} \times \left(\ Y + \frac{Z}{10000}\ \right)\ \%\ \text{of current range}\ \right]$$

EXAMPLE 1: Accuracy using 10 ma DC A-90 range with 891A.

A-90 Specification (from Table 6-1) | 891A Specification (from 891A Data Sheet)

$$\pm\ 0.1\ \% \qquad \pm\ (\ 0.01\ \%\ \text{of input} + 0.001\ \%\ \text{of range} + 10\ \text{uv}\ )$$

Vr 1.0 (891A's 1v DC Range)

$$= \pm\ \left[\ (0.1 + 0.01\ )\ \%\ \text{of current input} + \frac{1.0}{0.1} \times (\ 0.001 + \frac{10}{10{,}000}\ )\ \%\ \text{of current range}\ \right]$$

$$\pm\ \left[\ 0.11\%\ \text{of current input} + 0.02\%\ \text{of current range}\ \right]$$

$$= \pm\ \left[\ 0.11\%\ \text{of current input} + 2\ \text{ua}\ \right]$$

Figure 6-5. EQUATION 1 – COMBINING A90 AND VOLTMETER SPECIFICATIONS (Sheet 1 of 2)

EXAMPLE 2: Accuracy using 0.1 ma AC A-90 range with 873A at 1 kHz.

Model 873A has 1 megohm input impedance in its AC mode so separate accuracy statements are required for positive and negative limits of error for measurements made on the A-90's 0.1 ma range.

Positive Limit of Error

A-90 Specification: + | 0.0 | %

873A Specification: ± | 0.2 | % of input + | 25 | uv

"Vr" is 873A's 1v AC Range

No "Y" Term In Spec.

$$= +\left[(0.0 + 0.2)\ \%\ \text{of current input} + \frac{1}{0.1} \times \left(0 + \frac{25}{10000}\right)\ \%\ \text{of current range}\right]$$

$$= +\left[\ 0.2\%\ \text{of current input} + 0.025\%\ \text{of current range}\ \right]$$

Negative Limit of Error

$$= -\left[\ (0.2 + 0.2)\ \%\ \text{of current input} + 0.025\%\ \text{of current range}\ \right]$$

$$= -\left[\ 0.4\%\ \text{of current input} + 0.025\%\ \text{of current range.}\ \right]$$

Figure 6-5. EQUATION 1 – COMBINING A90 AND VOLTMETER SPECIFICATIONS (Sheet 2 of 2)

cation consists of "Y" term only. If "X", "Y", or "Z" do not appear in a voltmeter accuracy specification, it should be treated as a zero in Equation 1. The voltmeter must be used on the lowest range that can measure 100 millivolts. This range is assigned the symbol "V_r" in Equation 1. V_r is always stated as volts, i.e., 100 millivolt range equals 0.1 volts for V_r .

6-21. Equation 2 (Figure 6-6) may be used to convert the voltmeter voltage reading to current.

6-22. THEORY OF OPERATION

6-23. The schematic diagram of the Model A90 is located at the back of the manual. In the milliampere ranges, current is directed through the appropriate shunt resistor by switches S1A through S5A, and the corresponding output voltage is connected to the output terminals through switches S1 through S5, decks B and C. In 10 ampere range, the input current is applied directly to the shunt resistor, and the output voltage is connected to the output terminals through switch S6.

6-24. All shunt resistors are four-terminal shunts or are connected in a four-terminal switching arrangement so that lead resistance does not affect measurement accuracy.

6-25. MAINTENANCE

6-26. The following paragraphs contain instructions for cleaning and calibrating the Model A90.

6-27. Cleaning

6-28. The instrument should be cleaned periodically to remove dust, grease, and other contamination. The following procedure should be adhered to when cleaning the instrument:

a. Remove loose contamination with low-pressure, clean, dry air.

b. Clean front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened in a mild solution of detergent and water.

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents on the front panel, because they will react with the Lexan binding posts.

$$I_x = I_r \times \frac{V_d}{V_{dfs}}$$

Where:
- I_x = magnitude of unknown current in units of A90 "RANGE" used. (i.e. ma or amps).
- I_r = A90 Rated Current "RANGE".
- V_d = Voltmeter reading.
- V_{dfs} = Nominal Voltmeter reading with rated current flowing in A90. "V_{dfs}" and "V_r" are tabulated in Table 6-7 for each voltmeter listed in Tables 6-2 through 6-6. Note that "V_{dfs}" multiplies or divides "V_d" by powers of 10 so it is simple to manipulate.

EQUATION 2. CONVERTING VOLTAGE READINGS TO CURRENT

Example: An 8100A reads =.0643 when used with an A90 in the 10 ma range. What current is flowing?

- I_r = 10 ma (A90 "Rated Current Range")
- V_d = .0643 (Voltmeter reading)
- V_{dfs} = .1000 (From Table 6-7)

Answer: $I_x = 10 \text{ ma} \times \frac{.0643}{.1000} = 6.43 \text{ ma}$

Figure 6-6. Equation 2 – CONVERTING VOLTAGE READINGS TO CURRENT

6-29. Test Equipment

6-30. Test equipment required for calibration and testing of the Model A90 is shown in Table 6-8. If the recommended equipment is not available, other equivalent equipment may be used.

Table 6-8. LIST OF TEST EQUIPMENT

NAME	RECOMMENDED EQUIPMENT
Constant Current Source	Fluke Model 382A
DC Differential Voltmeter	Fluke Model 895A or 885A
Low-Thermal Leads	
4-Terminal Ohmmeter	Fluke Model 8300A with Option -02

6-31. Calibration

6-32. PRELIMINARY CHECKS. Make the resistance checks shown in Table 6-9. Values are approximate since check is intended to show only gross errors, such as defective or open resistors.

6-33. .1 MA AND 1 MA RANGE CHECKS. Connect the ohmmeter and A90, as shown in Figure 6-7, for 4-terminal resistance measurements, and perform the following steps:

a. Set the A90 to the .1 MA range. The ohmmeter should indicate between 1.00050 and 0.99950 kilohms. If the measured resistance is not within these limits, the .1 MA shunt, R6, is defective and must be replaced.

b. Set the A90 to the 1 MA range. The ohmmeter should indicate between 100.07 and 99.93 ohms. If the measured resistance is not within these limits, the 1 MA shunt, R5, is defective and must be replaced.

6-34. 10 MA, 100 MA, AND 1000 MA RANGE CHECKS. Connect the constant current generator, differential voltmeter, and A90 as shown in Figure 6-8 and perform the following steps:

a. Set the A90 to the 10 MA range.

b. Set the differential voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	0.100000

Table 6-9. RESISTANCE CHECKS

OHMMETER CONNECTIONS	MODEL A90	
	RANGE	APPROXIMATE RESISTANCE (OHMS)
INPUT Terminals	.1 MA	1000
	1 MA	100
	10 MA	10
	100 MA	1
	1000 MA	0.1
	10A	∞
INPUT (10A Terminals)	10A	0.01
OUTPUT Terminals	10A	0.01
	1000 MA	0.1
	100 MA	1
	10 MA	10
	1 MA	100
	.1 MA	1000

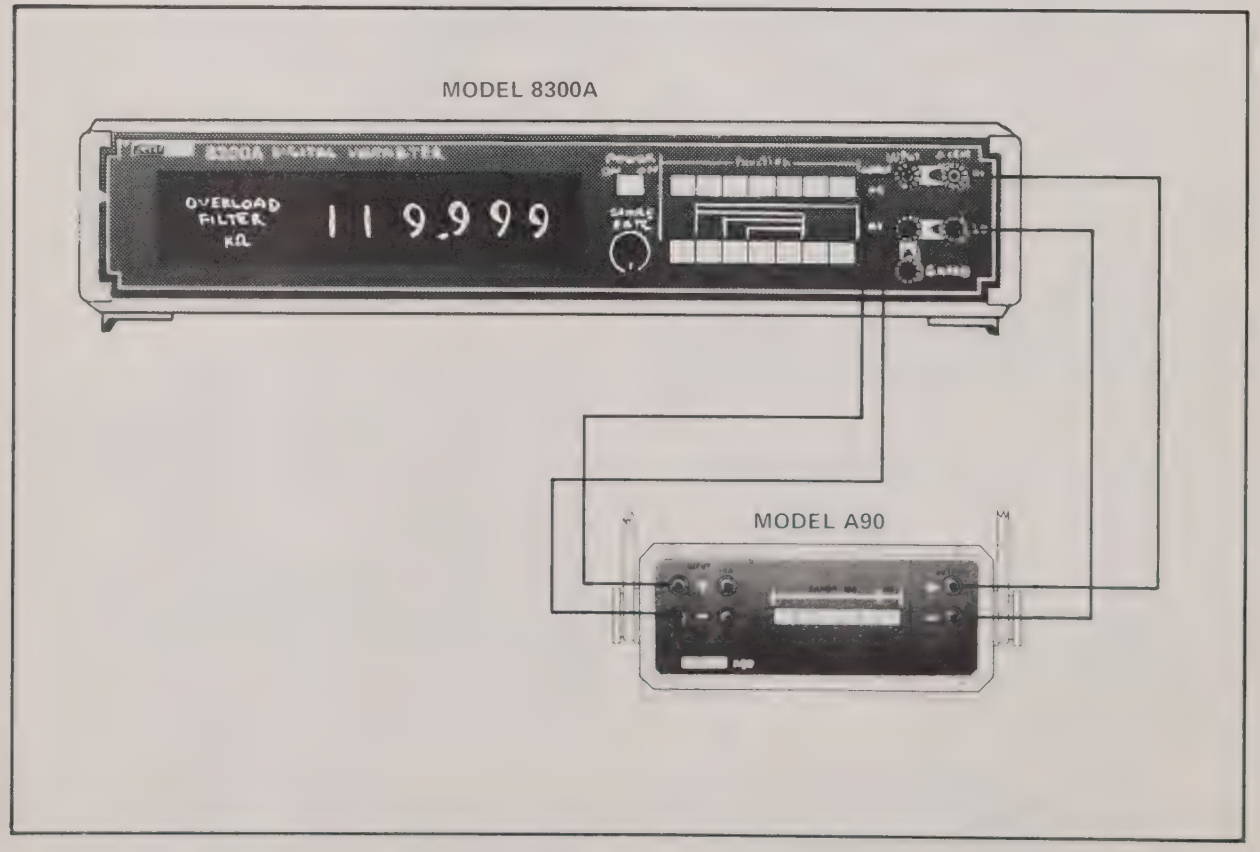


Figure 6-7. EQUIPMENT CONNECTIONS – .1 MA AND 1 MA RANGE CHECKS

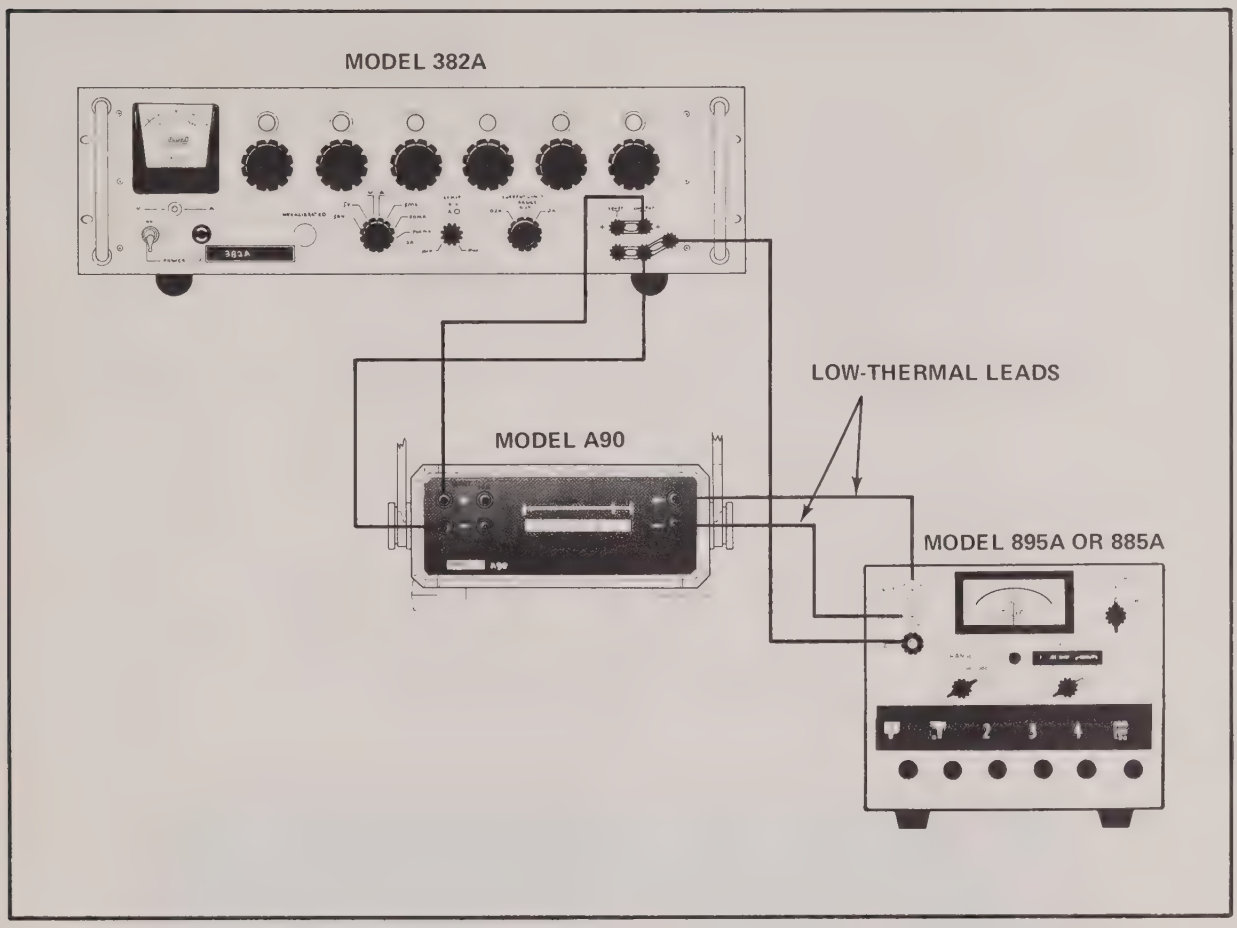


Figure 6-8. EQUIPMENT CONNECTIONS – 10 MA, 100 MA, AND 1000 MA RANGE CHECKS

c. Set the constant current generator for 10.0000 milliamperes output. The differential voltmeter should indicate null within ±80 micorvolts. If the voltmeter does not indicate within these limits, the 10 MA shunt, R4, is defective and must be replaced.

d. Change the A90 range to 100 MA and the constant current generator output to 100 milliamperes. The differential voltmeter should indicate null within ±80 microvolts. If the voltmeter does not indicate within these limits, the 100 MA shunt, R3, is defective and must be replaced.

e. Change the A90 range to 1000 MA and the constant current generator output to 1000 milliamperes. The differential voltmeter should indicate null within ±80 microvolts. If the +80 microvolt limit is not met, the 1000 MA shunt, R2, should be replaced. If the –80 microvolt limit is not met, R2 is low in ohmic value and can be trimmed to its desired value by carefully removing a small amount of material from the edge of the shunt using a whetstone.

6-35. 10 AMPERE RANGE CHECK. Connect equipment as shown in Figure 6-8, leaving the constant current generator temporarily disconnected from the A90, and perform the following steps:

a. Set the differnetial voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	0.00000

The voltmeter should indicate less than ±4 microvolts of thermal offset. If more than ±4 microvolts of offset is observed, check for cold solder joints or possible thermal generators in the test

setup. When thermal offset has been reduced to within ±4 microvolts, proceed to step (b).

b. Connect the constant current generator to the 10 AMP binding posts of the A90 and set the A90 to the 10A range.

c. Set the differential voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	.020000

d. Set the constant current generator output to 2 amperes. The voltmeter should indicate null within ±80 microvolts. If the +80 microvolt limit is not met, the 10 ampere shunt, R1, should be replaced. If the −80 microvolt limit is not met, R1 is low in ohmic value and can be trimmed to its desired value by carefully removing a small amount of material from the edge of the shunt using a whetstone.

6-36. LIST OF REPLACEABLE PARTS

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		CURRENT SHUNT — Figure 6-9	A90					
		Shunt PCB Assembly (See Figure 6-9)	A90-403	89536	A90-403	1		
J1, J2, J5		Binding post, red, +	275552	89536	275552	3		
J3, J4, J6		Binding post, black –	275560	89536	275560	3		
		Cover, bottom	224360	89536	224360	1		
		Cover, top	224352	89536	224352	1		
		Foot	230037	89536	230337	4		
		Handle, carrying	231423	89536	231423	1		
		Panel, front	A90-208	89536	A90-208	1		
		Panel, rear	A90-209	89536	A90-209	1		

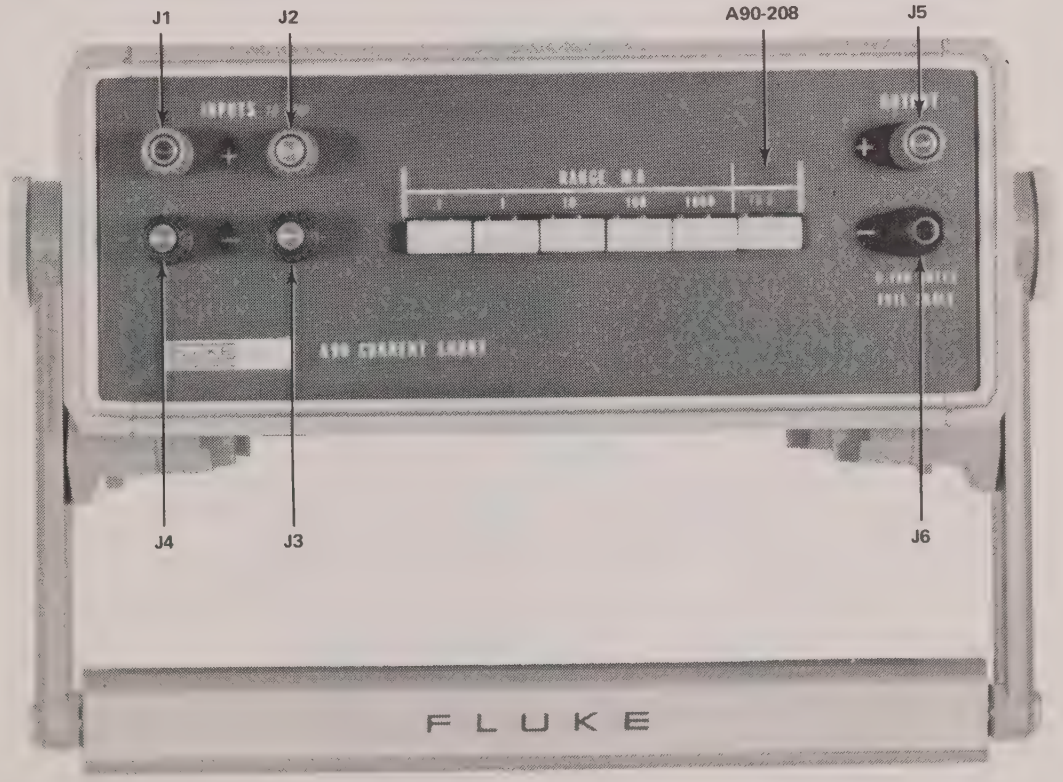


Figure 6-9. MODEL A90 CURRENT SHUNT (Sheet 1 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		SHUNT PCB ASSEMBLY – Figure 6-9	A90-403	89536	A90-403	REF		
R1		Res, ww, 0.010Ω ±0.2%, 1w	34-4022	89536	34-4022	1		
R2		Res, ww, 0.10Ω ±0.1%, 1w	224121	89536	224121	1		
R3		Res, ww, 1.0Ω ±0.1%, ½w	224089	89536	224089	1		
R4		Res, ww, 10Ω ±0.1%, ½w	224071	89536	224071	1		
R5		Res, ww, 100Ω ±0.03%, ½w	155846	89536	155846	1		
R6		Res, ww, 1 KΩ ±0.04%, ½w	131706	89536	131706	1		
S1 thru S6		Switch assembly, RANGE MA	A90-802	89536	A90-802	1		

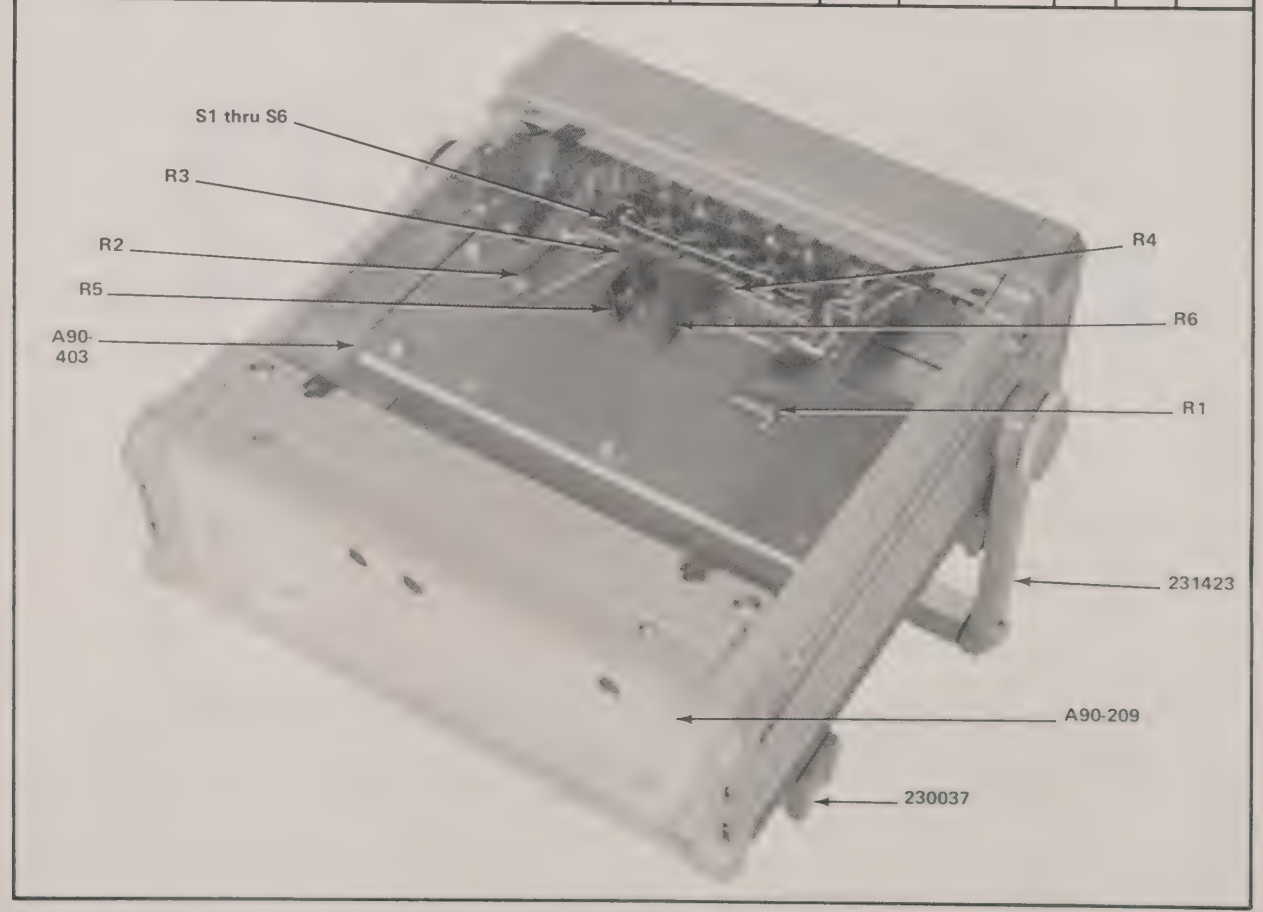
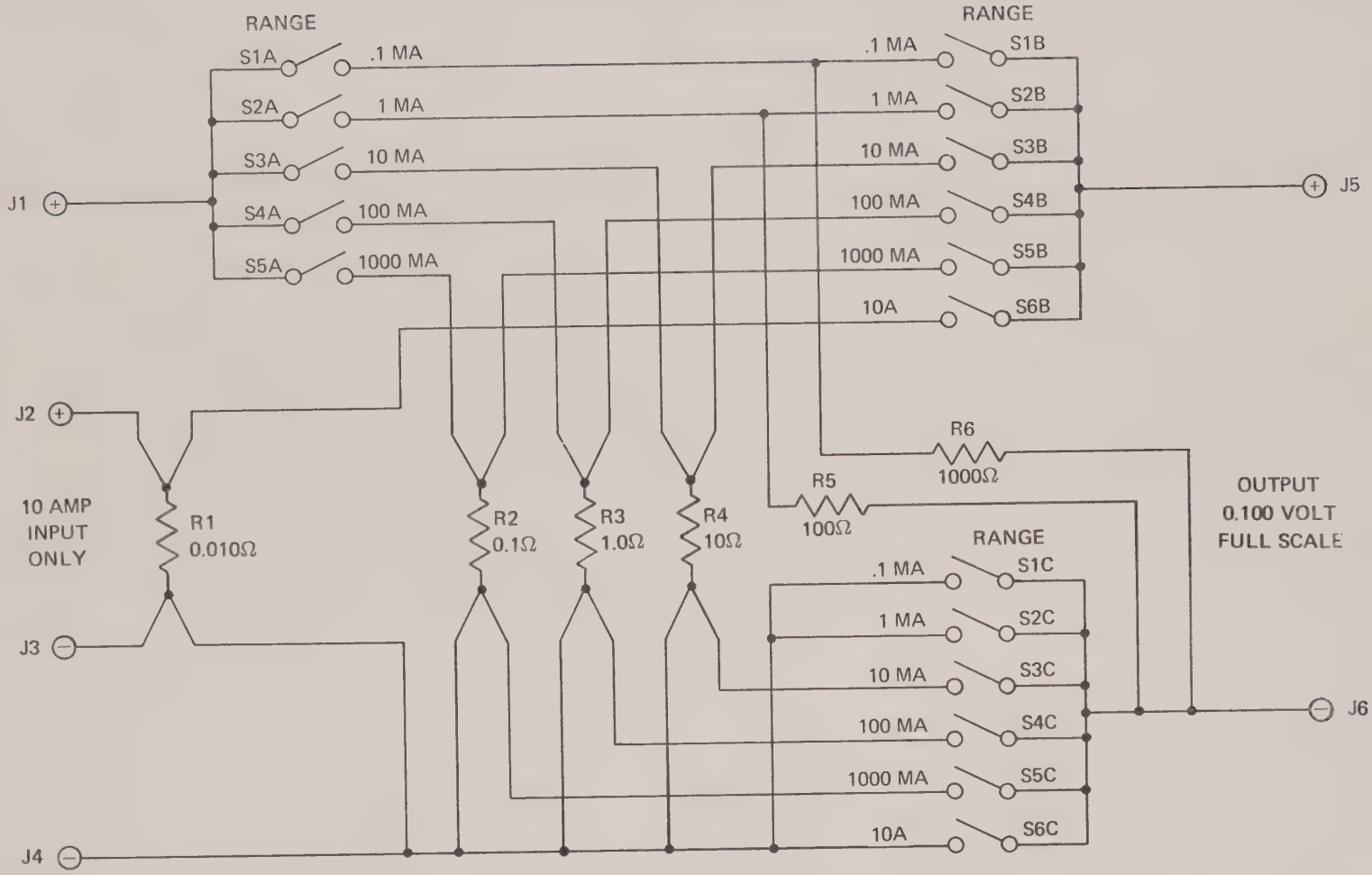
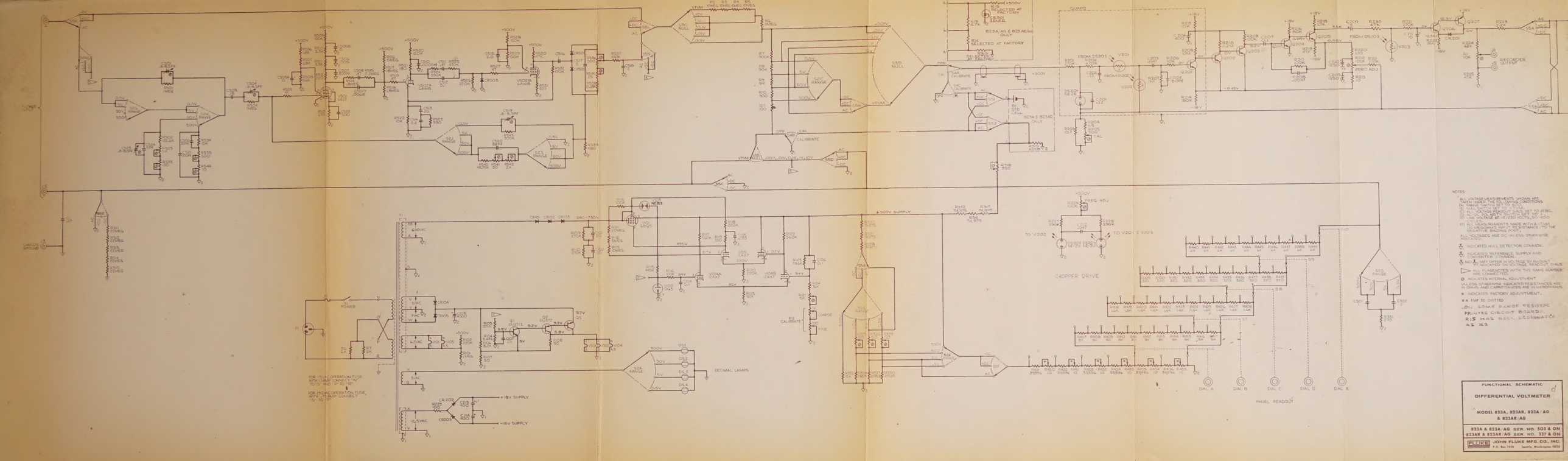


Figure 6-9. MODEL A90 CURRENT SHUNT (Sheet 2 of 2)



FUNCTIONAL SCHEMATIC DIAGRAM	
MODEL A90 CURRENT SHUNT	
SER. NO. 123 & ON	REV a

FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133


NOTES
ALL VOLTAGE MEASUREMENTS SHOWN ARE TAKEN UNDER THE FOLLOWING CONDITIONS
(A) RANGE SWITCH SET TO 500V.
(B) INPUT TERMINALS SHORTED.
(C) ALL VOLTAGE READOUT DIALS SET TO ZERO.
(D) NO DC VOLTMETER CONNECTED TO -45 VOLT LINE.
(E) LINE VOLTAGE AT 115/230 VAC, 50 TO 400 CPS.
(F) ALL MEASUREMENTS MADE WITH A 1 MEG OHM VOLTMETER WITH ITS LOW SIDE CONNECTED TO THE NEGATIVE BINDING POST.
ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
INDICATES NULL DETECTOR COMMON.
INDICATES REFERENCE SUPPLY AND COUNTER COMMON.
MAY DIFFER IN VOLTAGE BY AMOUNT AS INDICATED ON VOLTAGE READOUT DIALS.
ALL FLAGNOTES WITH THE SAME NUMBER ARE CONNECTED.
INDICATES INTERNAL ADJUSTMENT UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS AND CAPACITANCES ARE IN MICROFARADS.
INDICATES FACTORY ADJUSTMENT.
MAY BE OMITTED
ON SOME RANGE RESISTORS PRINTED CIRCUIT BOARD, R15 HAS BEEN DESIGNATED AS R3
FUNCTIONAL SCHEMATIC
DIFFERENTIAL VOLTMETER
MODEL 823A, 823AR, 823A/AG & 823AR/AG
823A & 823A/AG SER. NO. 503 & ON
823AR & 823AR/AG SER. NO. 327 & ON
JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133